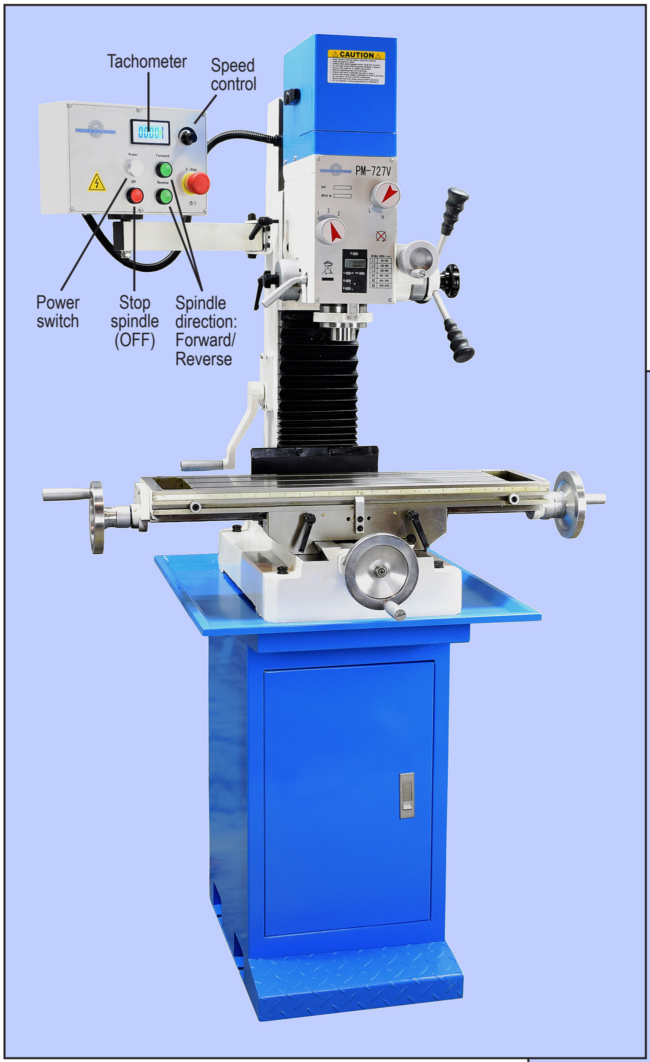
Models PM-727M & PM-727V

Precision milling machines

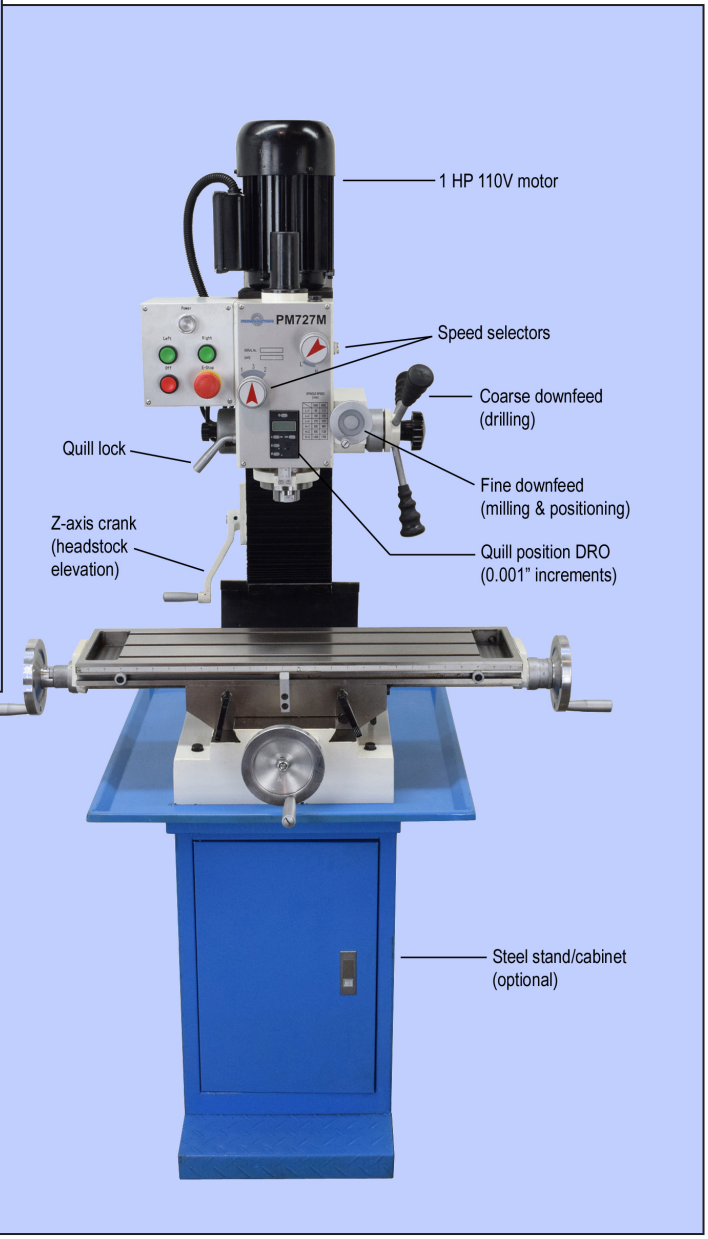
PM-727M 6-speed gear head (6 set speeds)
PM-727V 6-speed gear head (6 speed ranges, infinitely adjustable speed in each range)

110Vac power
Quill DRO for precise downfeed measurement
Square column design, dovetail ways
Heavy cast iron construction
Optional steel stand & cabinet
Weight including stand 575 lbs



Model PM-727V (brushless dc motor)

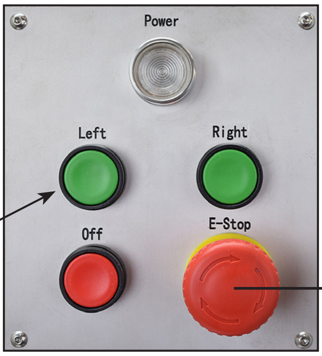
Model PM-727M (ac induction motor)


1 HP 110V motor
PM727M
Speed selectors
Coarse downfeed (drilling)
Quill lock
Fine downfeed (milling & positioning)
Z-axis crank (headstock elevation)
Quill position DRO (0.001" increments)
Steel stand/cabinet (optional)

PRECISION MATTHEWS

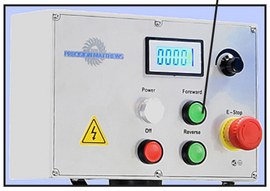
FAQ

My mill doesn't run at all

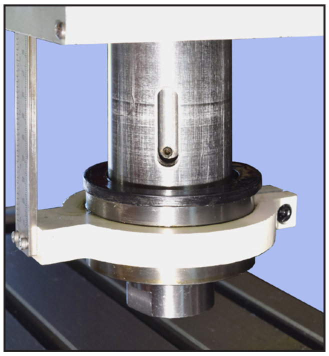


110 Vac power connected?
Power lamp lit? (Press the
Power push-button lens)
E-Stop button in? (pop it out
by twisting firmly to the right.)
Fuse good?

PM-727M shown above. The PM-727V panel, left, is labeled differently (727V Forward = 727M Left, Reverse = Right).



R8 collets won't go into the spindle



The collet locating screw could be in too far. Back it out a little.

This manual contains essential safety advice on the proper setup, operation, maintenance, and service of the PM-727M and PM-727V mills. Failure to read, understand and follow the manual may result in property damage or serious personal injury.

There are many alternative ways to install and use a milling machine. As the owner of the machine you are solely responsible for its proper installation and safe use. Consider the material contained in this manual to be advisory only. Quality Machine Tools, LLC cannot be held liable for injury or property damage during installation or use, or from negligence, improper training, machine modifications or misuse.

This manual describes PM-727 machines as shipped from January 2015. There may be detail differences between your specific machine and the information given here (with little or no impact on functionality). Please email us if you have questions about any aspect of the manual or your machine (see our website www.precisionmatthews.com for support addresses). Your feedback is welcomed!

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New installation?

These are the points to watch out for!

But read the whole manual for specifics

After uncrating the mill, please pay attention to the following:
- Handling the mill is at least a two-man job.
- Read the installation instructions, Section 2 of this manual.
- Handling the mill is at least a two-man job.
- Lower the center of gravity by cranking the headstock down until the spindle nose is just clear of the table.
- Lifting gear – sling, hoist or forklift – must be rated for at least 1000 lb.

Working location of the mill must allow:
1. Full left-right travel of the table.
2. Access to the back of the column for Z-axis leadscrew maintenance (if against a wall, make sure it can be moved if access is required).

- Power requirement is 110V, 60Hz, 1φ, 20A circuit protection .
- Extension cord ***not recommended***; if no alternative, use 12 AWG not longer than 20 ft.

Before connecting power be sure that:
1. The machine is on a firm footing.
2. No chuck or collet is installed, and the drawbar is removed.
3. There are no clamps or locks on moving parts.
4. The gearbox contains OIL – check the sight glass at right of the headstock.
5. The gear levers are set for the lowest speed: Hi-Lo to L, 2-3-1 to 1.
6. The gears are fully engaged – hand-rotate (jiggle) the spindle forward and back while applying light pressure on each gear lever, listening for the click as the gears engage.

Section 1 FEATURES & SPECIFICATIONS

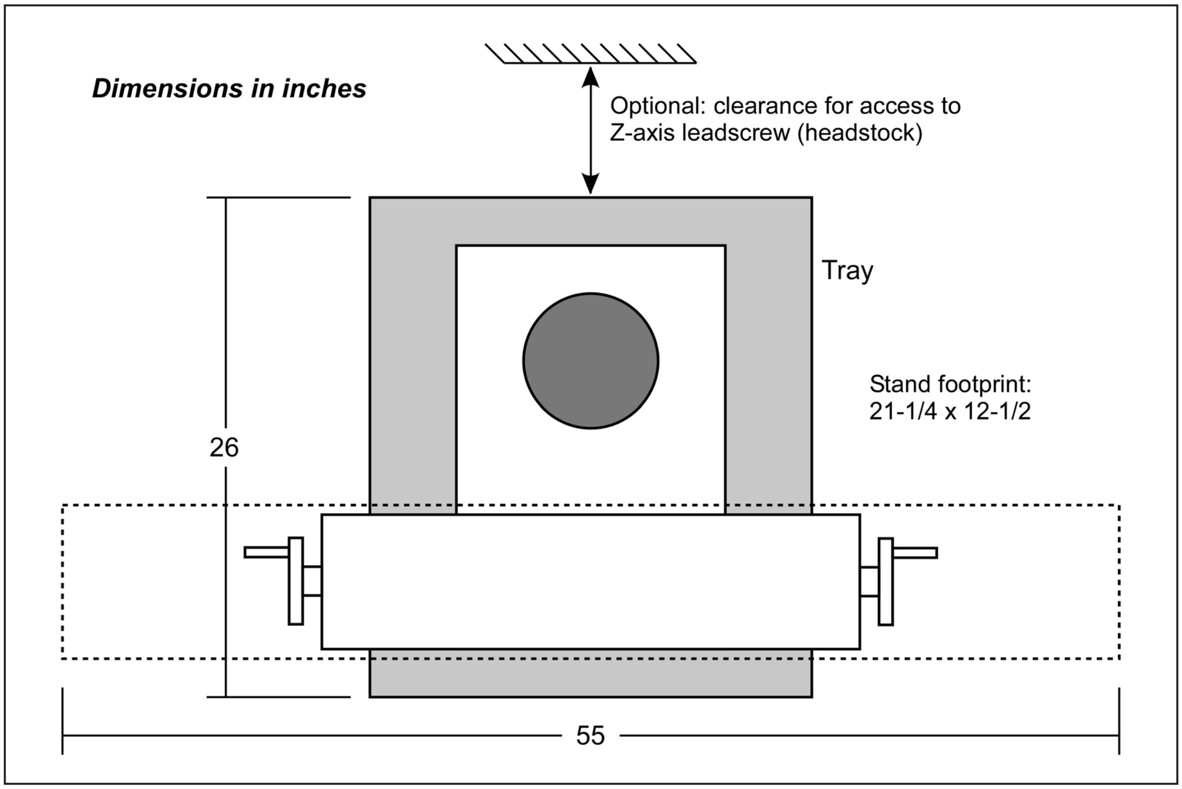
MODEL PM-727M and PM-727V MILLING MACHINES

General information

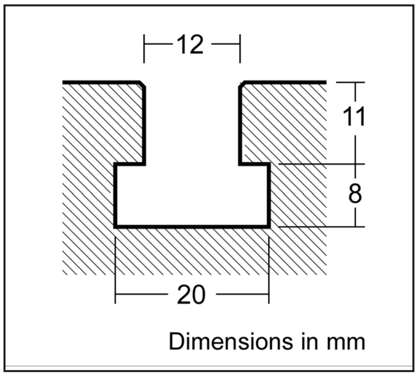
These are robust “square column” mills designed for use in the model shop. With an all-up weight of almost 600 lbs (including the optional stand), they can handle far more than the typical small machine. For precise control of cutter depth there is a worm-driven quill downfeed with graduated dial and DRO, completely independent of headstock up/down position.

The main difference between M and V models is the motor — single speed ac (induction type) for PM-727M, variable speed (brushless dc) for the PM-727V. The V model offers a significantly wider speed range than the M model, 40-3000 rpm vs. 115-1700 rpm.

The reversible spindle runs in high-quality tapered-roller bearings enclosed in a 2-1/2” diameter quill with coarse and fine downfeed options. In the PM-727M an oil-filled gearbox provides 6 spindle speeds from 115 to 1700 rpm. The same gearbox in the PM-727V provides 6 speed ranges from 40-190 to 1800-3000 rpm. Ground dovetailed ways for table and headstock ensure smooth, precise motion in all three axes (X = table left/right, 15 in. Y = table front/back, 8-1/2 in. Z = headstock up/down, 16 in.). The headstock can be tilted 90 degrees clockwise and counter-clockwise from the vertical.


Dimensions in inches
Optional: clearance for access to Z-axis leadscrew (headstock)
Tray
Stand footprint: 21-1/4 x 12-1/2
26
55

Working clearances – space requirements for full motion of the table



Approximate T-slot dimensions

Model PM-727M and PM-727V specifications

Dimensions	
Weight, including optional stand	575 lb net (475 lb without stand)
Size, assembled on stand	W 40 in. x D 26-1/2 in. x H 70 in.
Stand footprint	W 14-1/2 in. x D 21-1/4 in.
Tray	W 23-1/4 in. x D 26-1/4 in.
Electrical	
Power requirement	120V, 60 Hz, 1 phase
Spindle motor PM-727M	Cap-start induction, 900W (1.2 HP), 1720 rpm
Spindle motor PM-727V	Brushless dc, 1125W (1.5 HP), variable speed
Headstock	
Vertical travel	16 in.
Left-right tilt	90° - 0° - 90°
Spindle	
PM-727M Spindle speed, rpm	115, 220, 320, 600, 1120, 1700
PM-727V Spindle speed, rpm	40-190, 180-380, 350-560, 550-1000, 980-1860, 1800-3000
Internal taper	R8
Top end	6 splines, 22 mm OD
Quill travel	3 in.
Quill diameter	2-1/2 in.
Spindle nose to table	2-1/2” to 18-1/4 in.
Spindle centerline to front face of column	7-3/4 in.
Drawbar	7/16 - 20, 16 mm wrench
Table	
Size	W 27-1/2 in. x D 7-1/4 in.
Surface height over floor	Approx 36 in.
Maximum load, centered	200 lb
Leadscrews	Acme, inch pitch, 10 tpi
Left-right travel (X-axis)	15 in.
Front-back travel (Y-axis)	8-1/2 in.
T-slots (3)	12 mm wide, 63 mm centerlines

ABOUT THIS MANUAL ...

It was written before the PM-727V became available. Unless otherwise noted, all descriptions, suggestions and instructions apply equally to both PM-727M and PM-727V machines. They are identical in all respects other than the motor, single speed for the M model, variable for the V.

Everyday precautions

- This machine is designed for milling and drilling operations by experienced users familiar with metal-working hazards.
- Untrained or unsupervised operators risk serious injury.
- Wear ANSI-approved full-face or eye protection at all times when using the machine (everyday eyeglasses are not reliable protection against flying particles).
- Wear proper apparel and non-slip footwear – be sure to prevent hair, clothing or jewelry from becoming entangled in moving parts. Gloves – including tight-fitting disposables – can be hazardous!
- Be sure the work area is properly lit.
- Never leave chuck keys, wrenches or other loose tools on the machine.
- Be sure the workpiece and machine ways are secure before commencing milling or drilling – hold-downs and/or vise fully tightened, X-Y-Z axes locked, cutting tool secured.
- Use moderation: light cuts, low spindle speeds, slow table motion give better, safer results than “hogging”.
- Don’t try to stop a moving spindle by hand – allow it to stop on its own.
- Disconnect 110V power from the mill before maintenance operations such as oiling or adjustments.
- Maintain the machine with care – check lubrication and adjustments daily before use.
- Clean the machine routinely – remove chips by brush or vacuum, not compressed air (which can force debris into the ways).

No list of precautions can cover everything. You cannot be too careful!

Section 2 INSTALLATION

SETTING UP THE MILL

The PM-727M is shipped in two packing cases, one for the machine, one for the optional stand. The following procedure makes use of an engine hoist, minimum weight rating 1000 lb.

If this is a stand installation, move the stand to the mill's working location. Make sure the back of the column will be accessible for lubrication (working clearances, Section 1).

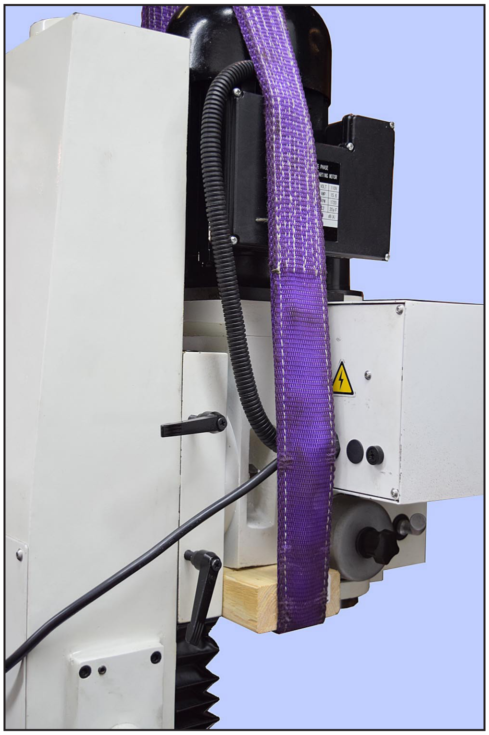


Figure 2-1 **Protect the capacitor housing**
An 18 inch length of 2 x 4 will reduce pressure on the plastic case

1. Un-crate the mill. Remove the drill chuck, if fitted.
2. Lower the center of gravity by cranking the headstock down.
3. Tape cloth padding to the underside of the tilt collar.
4. Run a sling under the padding.
5. Hook the sling to the hoist, but do not lift before completing the next step.
6. Place a wood stretcher under the headstock to hold the sling away from the capacitor housing, Figure 2-1.
7. Slowly lift the mill, controlling any tendency for it to swing as it clears the pallet.
8. Roll the mill to its working location, then lower it into place, Figure 2-2.
9. Secure the mill to the bench or stand. If this is a stand installation, use the four bolts supplied. The front two bolt locations are threaded. Use lock washers and nuts for the back two.
10. Level the mill using the table surface for reference, shimming as necessary.

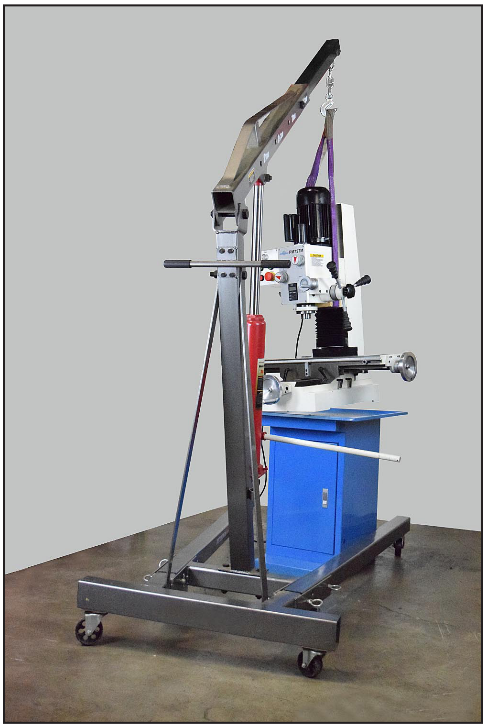


Figure 2-2 **Lower the mill onto stand or bench**

Assembly & cleanup

Unfinished metal surfaces may be protected in shipping by thick grease and/or paper. Carefully remove these using a plastic paint scraper, disposable rags and a light-oil such as WD-40.

Oil the ways and leadscrews. Check the headstock sight glass for oil level.

If necessary, install the X-axis handwheels.

Initial checks

Read Section 3 if unsure about any item

1. Connect 110 Vac power.
2. Be sure the E-Stop (Emergency) button is not pushed in (it pops out when twisted clockwise).
3. If the power lamp is unlit, press the Power button.

The power lamp should light.

4. Check the emergency function by pressing the E-Stop button. The power lamp should go out, de-energizing the contactor circuit, disabling all electrics.

   If this doesn't happen, the E-stop function is defective, and needs attention

5. Restore power by twisting the E-Stop button ***firmly clockwise***.

Test run procedure

DO NOT LEAVE THE MACHINE UNATTENDED DURING THIS PROCEDURE

! ***Allow the spindle to stop completely before shifting gears***

1. Gear levers set to L and 1 (115 rpm)? Gears fully engaged? Speed control fully counter clockwise, PM-727V only.
2. Test the spindle motor by pressing the Left and Right motor switches in turn.
3. Run the spindle at 115 rpm for a few minutes, then stop.
4. Select each of the available speeds in turn (L-2, L-3, H-1, etc.). Check gear engagement each time, then run for a few minutes.

The machine should now be ready for normal operations.

Optional

After a few hours of run time you may wish to drain the gearbox to flush out any residue from the manufacturing process. Refill the gearbox with the oil recommended in Section 4.

PM-727V USERS PLEASE NOTE ...

SPEED RANGES (rpm)

L1	40-190
L2	180-380
L3	350-560
H1	550-1000
H2	980-1860
H3	1800-3000

Not shown in Section 5:

- Spindle speed is transmitted to the tachometer on the control panel by a sensor located adjacent to spindle.
- The electrical schematic does not show the PM-727V variable speed drive. This replaces entirely the motor and motor witching circuit shown in the schematic.

Section 3 USING THE MILL

FRONT PANEL CONTROLS

Connect the mill to a 110Vac outlet. Press the **Power** lamp switch, top center Figure 3-1, to energize the control circuit (the lamp should light). This is a latching switch – press once to energize, press again to de-energize.

The **E-stop** button, bottom right, is in series with the Power switch. Like the Power switch, it de-energizes the control circuit completely, but it should be used only for its intended purpose – emergency disconnect. Once the E-stop button is pushed in, it stays in until twisted clockwise to release.

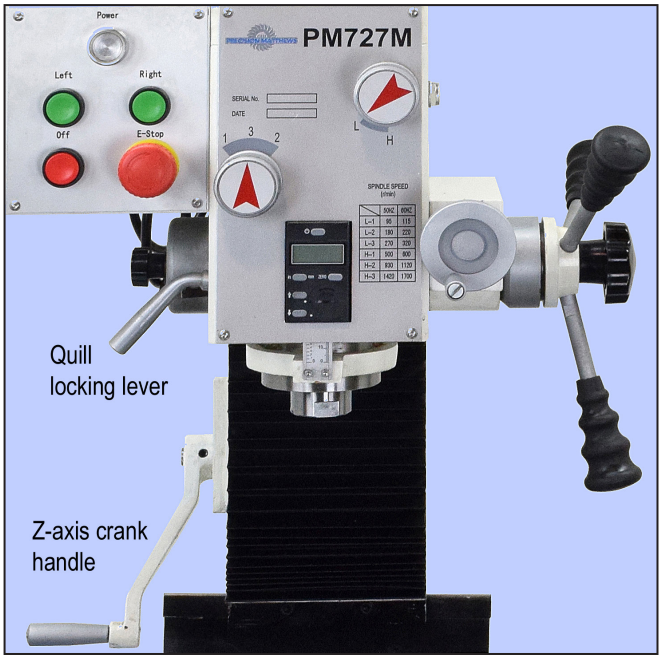


Figure 3-1 **Motor controls, gear shifters & DRO**

The spindle drive motor is controlled by the three push buttons:

Left = Forward (cw, looking down, used for most milling/drilling operations)
Right = Reverse (ccw, looking down)
Off = Stop

SPINDLE SPEEDS

This is a gear-head machine with a constant speed motor and a two-stage gearbox providing a choice of six spindle speeds. The first stage (L-H) selects the speed range, high or low; the second stage (1-3-2) selects a specific speed within that range.

Before switching on the spindle motor be sure that both stages are properly engaged. Hand-rotate (jiggle) the spindle forward and back while applying light pressure on each gear-shift knob, listening for the click as the gears engage.

Allow the spindle to stop completely before shifting gears

Spindle speeds (rpm)

L-1	115
L-2	220
L-3	320
H-1	600
H-2	1120
H-3	1700

Excessive cutter noise, chatter, poor finish and tool wear are often the result of too high a feed rate, and/or too high a spindle speed. If unsure, go slow!

INSTALLING & REMOVING TOOLING

The spindle and drawbar are designed for R-8 taper collets, drill chucks and other arbors with the standard 7/16”-20 internal thread.

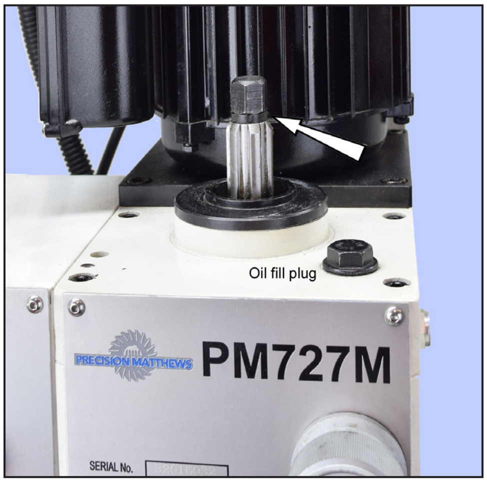


Figure 3-2 **Spindle & drawbar (arrowed)**

When installing or removing R8 tooling, set the spindle speed to L1 for the best braking action. Alternatively, an adjustable wrench can be used to grip the flats on the bottom end of the spindle.

To install: Hand-thread the drawbar into the R-8 device until the washer, arrowed in Figure 3-2, is seated on the splined spindle. ***Fully tighten*** the drawbar.

To remove: Protect the table under the spindle with rags or scrap wood. Loosen the drawbar one half turn or less — holding the spindle with a wrench if necessary — then tap the top of the drawbar with a brass or dead-blow hammer to unseat the taper. Unscrew the drawbar with one hand while ***supporting*** the R-8 device with the other hand.

Why support the R-8 item? Because the table, vises and workpiece can be damaged by falling tools and drill chucks. The cutting tool itself can also be damaged in the same way.

Replace the drawbar cap to protect bearings and spline

MOVING THE TABLE

Left-right movement of the table is usually said to be on the X-axis (a.k.a. "longitudinal travel" or "traversing"). Front-back movement is on the Y-axis, sometimes called "cross travel".

Each axis has a leadscrew with handwheel and graduated dial with 0.001" divisions, 0.1" per revolution, Figure 3-3. If the mill is not equipped with digital readouts (DROs), the table can be accurately positioned by counting whole turns and divisions, keeping ***leadscrew backlash*** in mind. This means that table motion must always be in the same direction up to the point of reference, then on to the desired location, see "Spindle Positioning by Counting Divisions" later in this section.

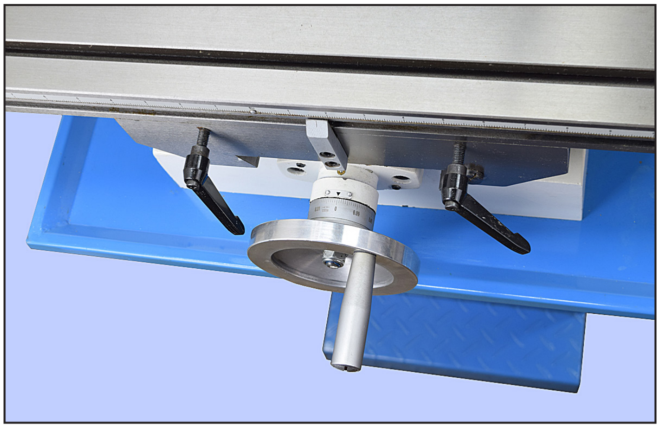


Figure 3-3 **Y-axis handwheel, X-axis clamp levers**

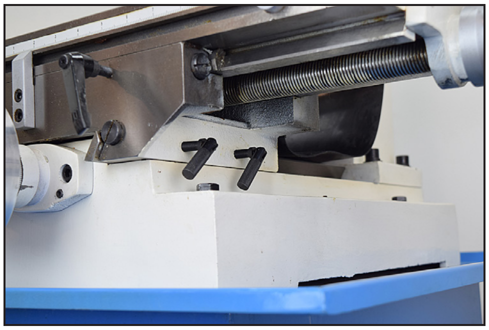


Figure 3-4 **Y-axis clamp levers**

QUILL DOWNFEED

The quill is controlled in two different ways, ***coarse*** and ***fine***.

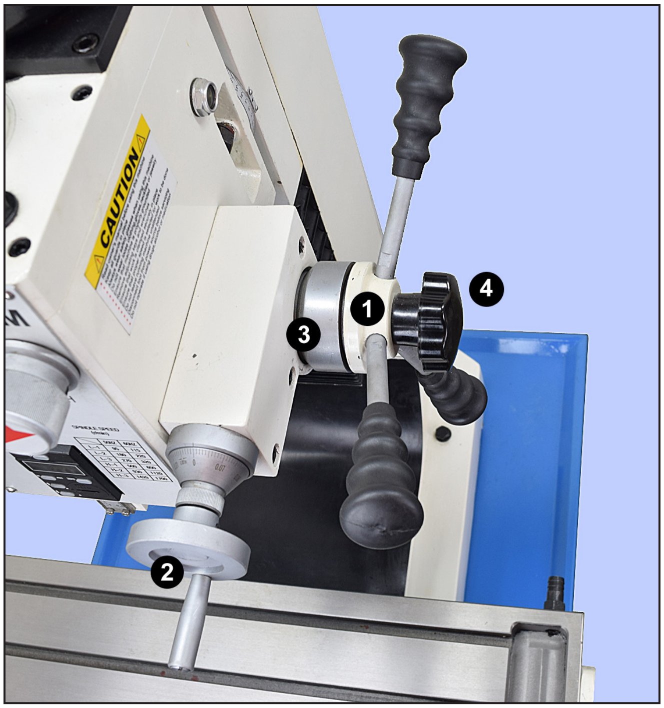


Figure 3-5 **Quill downfeed controls**
The quill pinion is driven by the lever hub (1). The fine control handwheel (2) is connected by a worm gear to sleeve (3), which is free to rotate — doing nothing to the quill — if it is not meshed with the lever hub. Do this by tightening knob (4).

In the drilling mode, coarse feed, the mill functions like a standard drill press – pull the upper lever toward you to lower the quill. For milling operations the 3-lever hub is disengaged, and the quill is controlled by the fine downfeed handwheel. The quill is locked by a lever on the left of the headstock, Figure 3-1.

Always lock the quill when milling

QUILL DOWNFEED

The quill is controlled in two different ways, ***coarse*** and ***fine***.

In the drilling mode, coarse feed, the mill functions like a standard drill press – pull the upper lever toward you to lower the quill. For milling operations the 3-lever hub is disengaged, and the quill is controlled by the fine downfeed handwheel. The quill is locked by a lever on the left of the headstock, Figure 3-1.

Coarse feed (Figure 3-5)
For drilling operations, loosen knob (4), allowing the lever hub to rotate independently of sleeve (3).

Fine feed (Figure 3-5)
For milling operations calling for precise, repeatable control of tool depth, tighten knob (4) to engage hub (1) with the internal taper on sleeve (3). Tighten the Z-axis clamps, Figure 3-7.

Rotate the fine control knob (2) to raise or lower the quill. Lower the quill by rotating the fine control knob clockwise, positioning it precisely either by counting divisions on the graduated dial, or by reference to the digital readout (DRO), Figure 3-1. Use the locking lever left of the headstock to hold the quill firmly in position.

If you are counting downfeed divisions be aware of backlash in the worm drive.

This means that the handwheel must always be ***turning in the same direction*** throughout the entire process, from setting a reference level to subsequent cutting passes at specific depths – see the backlash discussion in “Moving the Table”, above.

Using the DRO – which has no backlash issues – is less laborious, but remember that the quill is spring-loaded. This calls for care when releasing the quill locking lever prior to repositioning the quill downward. If the fine control knob has been allowed to disengage (backed off counter clockwise), the quill will jump up by 0.01” or more. To avoid this, make sure the fine control is firmly clockwise, lightly loading the quill rack, before releasing the locking lever.

X & Y-AXIS POSITIONING BY COUNTING DIVISIONS

For all spindle positioning operations, with or without DROs, avoid using the quill lock.

Why not use the lock? On vertical mills of this type, including the heavier knee mills, locking the quill may offset the spindle by a few thousandths of an inch. If the edge of the workpiece has been “found” in the quill-locked condition, this will affect placement of holes drilled thereafter. Instead, lower the quill with the fine downfeed control. This is worm driven, so it stays where it’s put without locking.

NOTE: This does not apply to operations calling for precise depth control, such as milling. For such operations the quill is locked to maintain a given depth of cut.

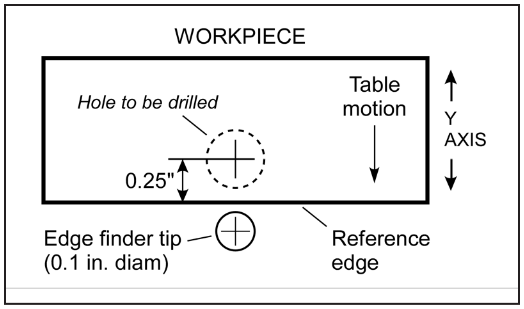


Figure 3-6 **Spindle positioning example**

In Figure 3-6 a hole is to be drilled 0.25” on the Y-axis relative to the ***front edge*** of a workpiece in a vise, or otherwise clamped to the table.

1. Install an edge-finder in collet or chuck (a tip diameter of 0.2” is assumed).
2. Clamp the X-axis by tightening both levers, Figure 3-3.
3. If the reference edge is already to the back the spindle centerline, do nothing; if not, rotate the Y-axis handwheel clockwise to send the workpiece backwards (toward the column).
4. Engage the fine downfeed, Figure 3-5.
5. With the spindle running, lower the quill as necessary using the fine downfeed handwheel; bring the table ***forward*** (counter-clockwise), stopping at the point where the edge-finder just makes contact (the tip jumps out of line). Stop the spindle.
6. While holding the Y-axis handwheel to prevent movement, zero the dial.
7. Raise the quill, then rotate the handwheel one ***exact*** full turn counter-clockwise (0.1”) to bring the reference edge to the spindle centerline.
8. Rotate the handwheel 2-1/2 turns counter-clockwise to bring 50 on the dial opposite the datum; the spindle is now exactly 0.25” behind the reference edge.

QUILL DRO

The quill DRO is in metric mode when switched on. Press the mm/in button to display inches. By pressing and holding the Up arrow (incrementing) or Down arrow (decrementing) the display can be set to a chosen value. To activate the Up/Down function press and hold the ZERO button until the letter ‘S’ is displayed at right (about 3 seconds). The longer the Up or Down buttons are held down, the faster the change in displayed value. Press the ZERO button briefly to exit the Up/Down mode.

Replace the battery by removing the small molded cover on the face of the DRO unit. Check the type number and voltage of the installed battery. Replace with an equivalent silver oxide cell available from local retailers.

Switch off the DRO when not in use!

HEADSTOCK ELEVATION (Z-AXIS)

The headstock is elevated by a hand crank on the left side of the column, Figure 3-1. For milling operations the headstock is usually locked in position by tightening the clamp levers, Figure 3-7.

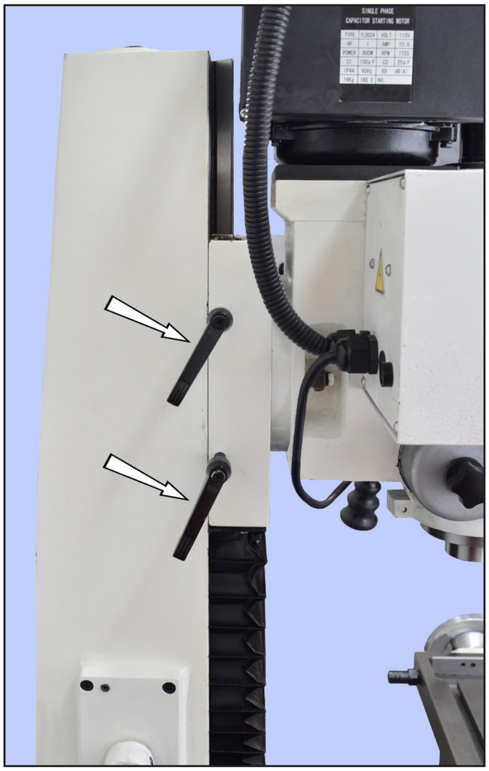


Figure 3-7 **Headstock clamp levers**

TAPPING OPERATIONS

When threading a drilled hole it is essential to align the threading tap properly in the bore. The mill is often used for this purpose, ideally with a dedicated (non-slip) tap holder or, for production work, an auto-reverse tapping attachment. The drill chuck can be used instead for sizes up to (say) M6 or 1/4”, beyond which the chuck may not grip tightly enough to avoid slippage. Tapping can be done under power, or by hand turning the chuck (see below). For either method, it is essential to use a tapping fluid. Any cutting oil is better than none, but most users find Castrol’s Moly Dee the most reliable for threading in steel. If power tapping bear in mind that reversing is not instantaneous, so be careful tapping blind holes. Be sure the quill locking lever is free, and start trial work with the lowest spindle speed, L-1.

The spindle must come to a stop before reversing

TILTING THE HEADSTOCK

In routine operations the user relies on squareness of the spindle relative to both axes of the table. Front-to-back squareness set at the factory, and is not adjustable (by everyday methods), but in the other plane the headstock can be set to any angle up to 90 degrees either side of the normal vertical position. Because re-establishing true vertical (tramming) on any mill is a time consuming process, most machinists look first for other ways of handling a project instead of tilting the head.

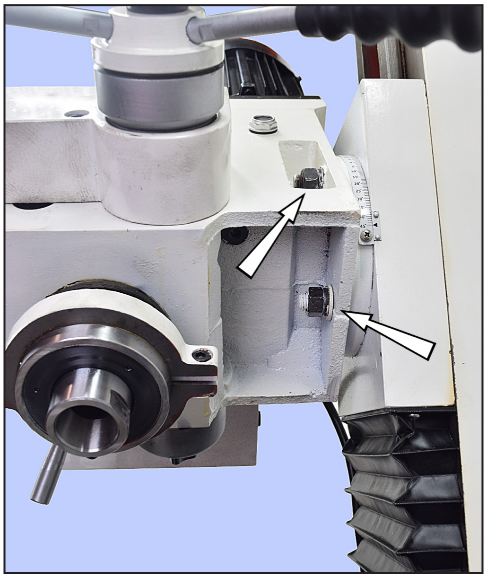


Figure 3-8 **Headstock nuts (2 of 3)**

The headstock is secured by three nuts spaced 120 degrees apart, one underneath and one either side, Figure 3-8. The headstock is top-heavy, and may swing suddenly to either side unless a helper is on hand to restrain it. Using an 18 mm wrench, testing for moveability as you go, carefully loosen the nuts by degrees. Be especially careful if the head has not been moved before

– the paint seal may let go without warning. (First-time tilting may also call for unusual effort on the wrench.)

Set the headstock to the desired angle by reference to the tilt scale on the headstock base casting, then retighten the nuts. The tilt scale was carefully installed in manufacture, and is good to within ± 1 degree. A more accurate means of angle measurement will be needed if the project calls for greater precision.

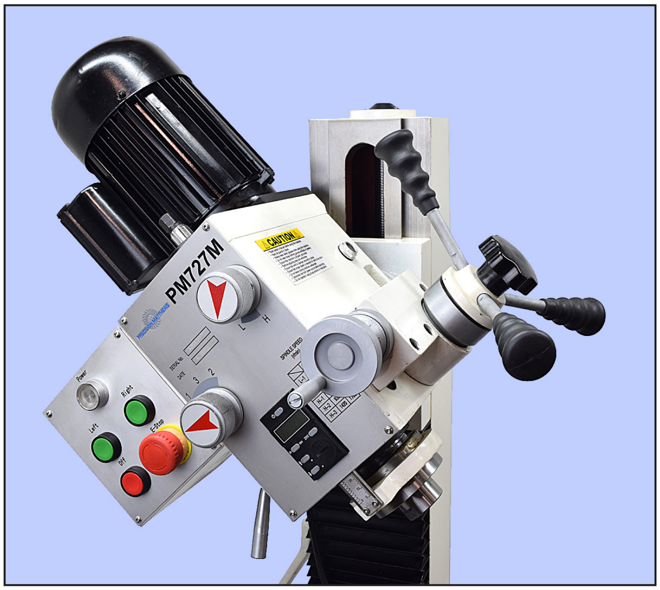


Figure 3-9 **Headstock tilted 45^{o} counter clockwise**

TRAMMING THE HEADSTOCK

As shipped, the mill is set to zero tilt, squared accurately enough for initial "out of the box" test drillings, etc. For more demanding project work thereafter, the spindle needs to be set at precisely 90 degrees relative to the table, in other words trammed. "Out of tram" may show up as an offset of a few thousandths between entry and exit of a deep hole, or as a scalloped effect when surfacing a workpiece with a large-radius fly cutter, exaggerated in Figure 3-10.

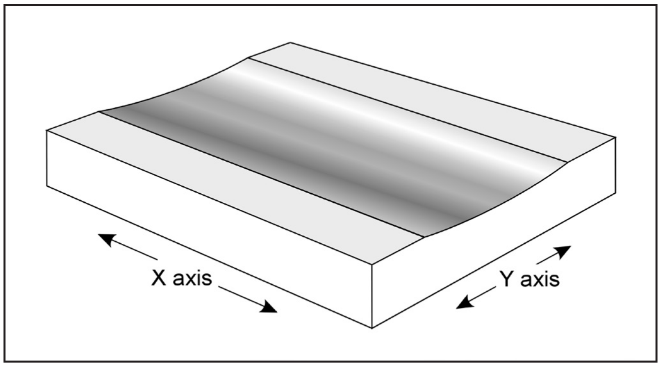


Figure 3-10 **Head tilt can affect surface flatness**

Tramming is done by fine-tuning the headstock tilt angle. Tram is typically checked by attaching a dial indicator to some form of "sweepable" holder installed in the spindle, the aim being to adjust tilt for the same reading on either side of the X axis. The longer the radius arm, the greater the sensitivity.

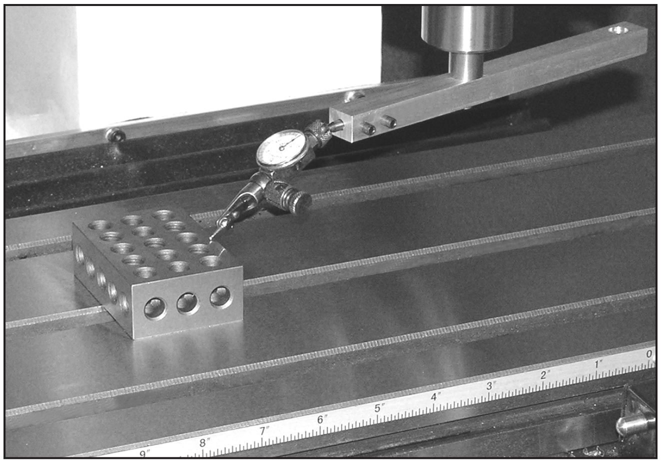


Figure 3-11 **Sweep holder for dial indicator**
The holder is a rectangular section aluminum bar with threaded holes allowing the choice of two sweep diameters, 6" and 10", measured from spindle centerline to indicator tip. The smaller sweep can be used for front-to-back tramming, also left-to-right as here. For more sensitive left-to-right tramming, use the larger sweep.

Tramming is the process of fine-tuning the headstock tilt angle. Start by attaching a dial indicator to some form of "sweepable" holder installed in the spindle, the aim being to adjust tilt for the same reading on either side of the X axis. The longer the radius arm, the greater the sensitivity.

Figure 3-11 shows a typical shop-made holder; it has a threaded arbor allowing the choice of two radius arms, 6 and 10 inches measured from spindle centerline to indicator tip. A collet is used to hold the arbor, in this example 5/8" diameter. The dimensions are arbitrary, but note that the indicator must be firmly attached, and the arm rock-solid relative to the indicator spring force (which can be considerable on plunger-type indicators). A suggested procedure for establishing tram:

1. Disconnect power.
2. Install the dial indicator.
3. Set the spindle drive to H-3 (this will allow the indicator holder to sweep easily from side to side).
4. If the headstock has been tilted, reset it to the approximate zero degree position on the tilt scale, then tighten the three nuts enough to avoid unexpected headstock movement.

5. Remove the vise, if installed, and clean the table surface. If there are noticeable grooves or dings, flatten the surface with a diamond lap or fine-grit stone.
6. Set a 1-2-3 block (or other precision-ground block) on the table under the indicator probe.
7. Switch on the DRO.
8. Using the fine downfeed lower the spindle to give an indicator reading of about half-scale.
9. Note both the dial indicator and DRO readings, then back off the fine downfeed at least a couple of turns to avoid collision when sweeping.
10. Reposition the 1-2-3 block to the opposite location on the table.
11. Swing the indicator holder to the new location, then lower the spindle – fine downfeed again – to give the same dial indicator reading as in step (7).

If the headstock is perfectly trammed – highly unlikely at the first shot – the DRO reading should be as in step (9). If not, loosen the nuts just enough to allow the headstock to be tapped a fraction of a degree in the direction called for, then re-tighten the nuts. The “tap” can be anything from a gentle slap of the hand to a rap with a dead-blow mallet.

Repeat steps (8) through (11) until satisfied with the tram, tightening the nuts as you go. This will likely call for several iterations. There is no “right” tram; the acceptable difference in side-to-side readings depends on project specs. As a starting point, aim for ± 0.001” on a sweep radius of 5 or 6 inches.

! ***Tramming calls for patience! Expect to tighten and re-check at least three times (simply tightening the bolts can itself affect the tram).***

A similar procedure may be used to check tram in the Y-axis, front to back. The difference here is that there is that Y-axis tram is established in manufacture, and can be adjusted by one of two methods:

1. Shimming between the dovetailed base casting and the headstock itself. It is more likely that the headstock is nodding forward rather than leaning backward, so start with (say) a 2 mil shim in line with the underside (central) headstock nut. This is a temporary fix that will need to be checked if the headstock is tilted again.
2. Shimming between the underside of the column and the main base casting. This is a long-term fix. It is a two-person procedure, requiring an engine hoist or some other means of un-weighting the headstock (see Section 2, Installation).

INSTALLING & INDICATING A VISE

For routine milling operations the workpiece is held in a precision vise. For the PM 727M a 4” vise is most suitable. “Indicating” means checking the alignment of the fixed (back) vise jaw relative to the axis of table motion.

Install the T-bolts and align the vise by eye. With one of the clamp nuts snug, but not tight, tighten the other one just short of fully-tight (but tight enough so the vise won’t budge without a definite tap from a dead-blow mallet).

A typical setup for indicating is shown in Figure 3-14. There is no spindle lock, but you need to ***make sure that the spindle does not rotate*** throughout the procedure. It helps to set the gears for the lowest spindle speed (L-1). Take up any backlash by pushing against the indicator holder. Set the indicator tip against the upper edge of a precision reference bar or, if not available, use the front face of the fixed jaw of the vise instead (check for dings, hone if necessary). Adjust the Y-axis to pre-load the indicator to mid range at the tightly-clamped side of the vise, then lock the Y-axis.

Note the indicator reading, then watch the indicator as you traverse the table slowly toward the loosely clamped side. Ideally, there should be no discrepancy between the indicator readings at the two ends — unlikely at the first attempt. Return the table to the starting point, then repeat the process, tapping the vise in as you go. Repeat the process as often as necessary for the desired accuracy, progressively tightening the “looser” nut. Now fully tighten both nuts, and re-check again (tightening a nut can itself introduce significant error). An established routine like this – tight to loose – can save a lot of time.

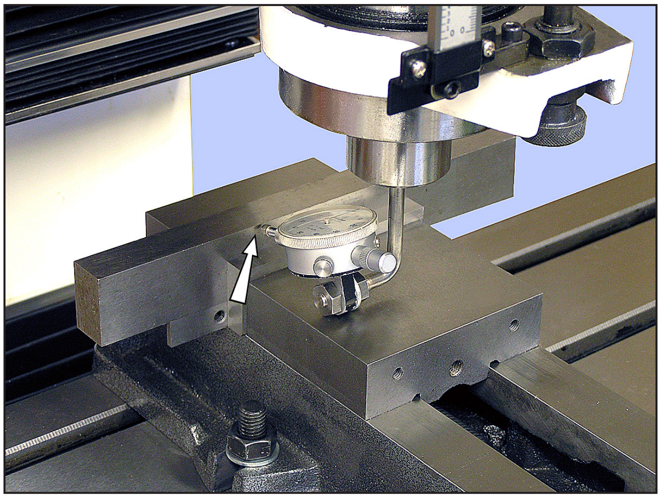


Figure 3-14 **Indicating the vise**
The tip of a standard dial indicator, arrowed, rides along the face of a ground reference bar

There is no “right” setup for a vise, but as a starting point aim for an indicator difference of no more than ± 0.001” over the width of the jaw.

VISE KEYS

Most precision vises come with key slots on the underside machined exactly parallel to the fixed jaw. Key slots, Figure 3-15, can be a great time saver. Properly installed they allow the vise to be removed and replaced routinely, accurately enough for general machining ***without the need for indicating every time.***

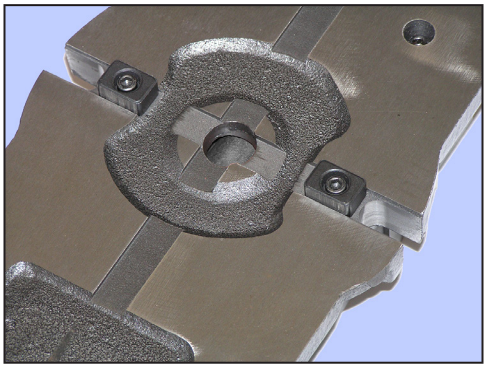


Figure 3-15 **Keys installed on X-axis of vise**
On most vises the keys can also be installed on the long axis

Most 4” vises have either 14 mm or 16 mm slots, calling for shop-made T-shape adapter keys as Figure 3-16. It is well worth the effort to make these precisely.

Aim for a snug fit in both vise and table, but not so tight that it takes more than reasonable effort to lift the vise clear. The objective is allow the vise to be removed and replaced routinely, accurately enough for general machining ***without the need for indicating every time***.

Case hardening of the keys is recommended, with final fitting using a fine stone or diamond stone.

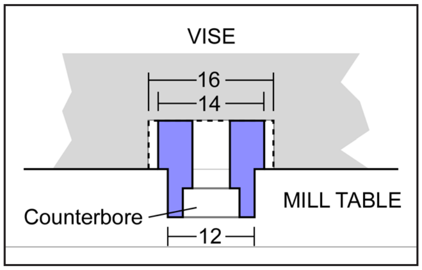


Figure 3-16 **Shop-made vise key**
Dimensions in millimeters

Section 4 MAINTENANCE

Unplug the 110V power cord before any maintenance operation!

LUBRICATION

ISO and SAE are the main indexes of viscosity. ISO has a "one number" scale, but SAE uses different indexes for engine and gear oils (there is also the suffix W, meaning multigrade). SAE 20 engine oil has about the same viscosity as SAE 80 gear oil, both roughly equivalent to ISO 68.

Recommended lubricants

Gearbox: ISO 68, such as SAE 80W90 auto gear oil, or Mobil DTE Heavy/Medium circulating oil (about 2 qts.)

Ball oilers: ISO 68 oil, such as Mobil Vactra No. 2, or equivalent

X, Y and Z axis ways (dovetails): ISO 68 oil, such as Mobil Vactra No. 2

Quill rack and pinion, Z-axis gears: light general purpose grease, NLGI No. 2, or equivalent

X and Y leadscrews: ISO 68 oil, such as Mobil Vactra No. 2, or equivalent

Z leadscrew: ISO 68 oil or NLGI No. 2 grease

GENERAL OILING

Assuming a clean environment – free from abrasive particles and machining debris – lack of proper lubrication is the main cause of premature wear. Rotating parts are easy to lubricate, sliding parts are not. Gibs are tightened for the best compromise between rigidity and slideability, which means practically zero gap between the ways. Take time to understand exactly which are the bearing surfaces on the various dovetail surfaces; this is not obvious – some of the interfaces look like bearing surfaces, but are simply narrow gaps.

Every few hours of operation:

1. Apply the recommended way-oil with a dedicated short-bristle brush such as the type used for applying flux.
2. Use a similar brush to apply oil or grease to the leadscrews
3. Apply oil to the ball oilers, see below.

Remove all machining debris and foreign objects before lubricating ANYTHING! If need be, any oil is better than no oil – but use the recommended lubricants when you can.

BALL OILERS

Use a pump-type oil can with tip large enough to more than span the oiler's spring-loaded steel ball. Oil pressure will displace the ball, allowing oil to flow, provided the oil can tip is firmly pressed onto the brass seating. Before oiling check that the ball is not stuck – press it lightly with a probe.

GEARBOX DRAIN & REFILL

1. Run the mill a few minutes to warm the oil if necessary.
2. Remove the fill plug on the top surface of he headstock.
3. Place a 1-gallon or larger drain pan under the headstock.
4. Using a 6 mm hex wrench remove the drain plug, Figure 4-1.
5. Allow the oil to drain completely, then replace the drain plug.
6. Remove the fill plug, then add just a few ounces of oil.
7. When satisfied that the headstock is oil-tight, add oil to the halfway mark on the sight glass (about 2 qts total).
8. Replace the fill plug.

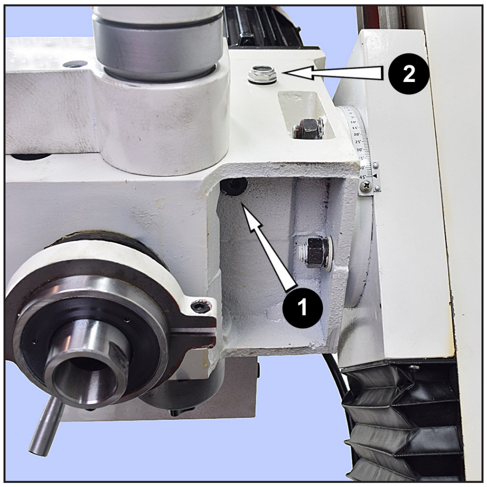


Figure 4-1 **Gearbox oiling**
Drain plug (1), sight glass (2)

QUILL RACK & PINION

Lower and lock the quill, Figure 4-2. Using a stiff flux brush, clean the visible portions of the rack and pinion.

QUILL RACK & PINION

Lower and lock the quill, Figure 4-2. Using a stiff flux brush, clean the visible portions of the rack and pinion. Raise and lower the quill to expose the remainder of the working surfaces, locking and cleaning at each setting.

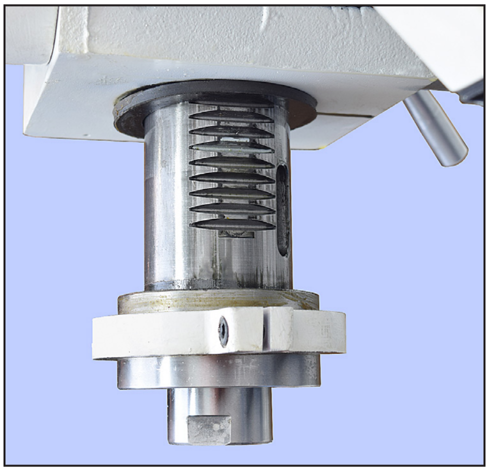


Figure 4-2 **Quill rack**

GIB ADJUSTMENT

Gibs on the X, Y and Z axes control the fit of the mating dovetailed surfaces. They are gently-tapered lengths of ground cast iron located by opposing screws at each end. Adjusting them is a trial and error process that takes time and patience. Aim for the best compromise of rigidity and reasonably free table movement. Too tight means accelerated wear on the ways and leadscrews. Too free means workpiece instability, inaccuracies and chatter.

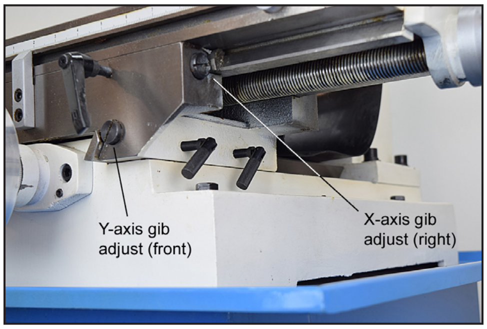


Figure 4-3 **X and Y-axis gib adjustment**
The back adjustment screw for the Y axis gib is under the solid way cover

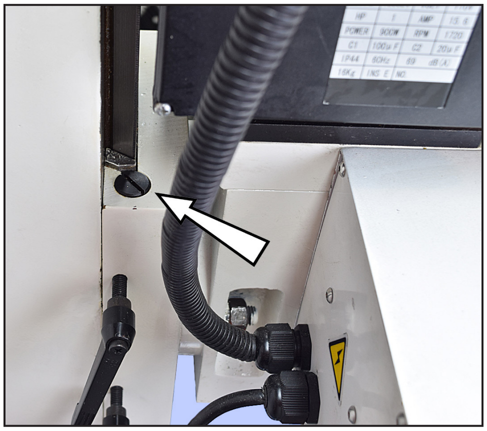


Figure 4-4 **Z-axis gib adjustment (top)**
The lower adjustment screw is under the pleated way cover

BOTH screw heads must be tight against the gib ends. If you loosen one, tighten the other. Remove the way covers for access to the back of the Y gib and bottom of the Z gib.

SPINDLE BEARINGS

The spindle runs on grease-lubricated tapered roller bearings. These should be serviced every 500 hours of running time. Thoroughly clean each bearing assembly then repack with a grease such as Kluber Isoflex (auto shop wheel bearing grease can be substituted in low-load, low rpm operations). ***Do not over-pack the bearings!*** Bearing manufacturers recommend that the free volume between inner and outer should be no more than 30% filled with grease. (If smothered with grease, bearings are subject to overheating.)

Especially during the first 10 hours of running time check that the spindle runs smoothly, without excessive heat build up (the spindle will run warm when used at high speeds over long periods, but should not be uncomfortably hot). Overheating can be due to excessive grease, see above, or an over-tight spanner nut at the upper end of the spindle. Call Precision Matthews for guidance.

LEADSCREW BACKLASH CORRECTION

When alternating between clockwise and counter clockwise rotation of the X or Y leadscrews, the handwheel moves freely a few degrees but the table stays put. This is backlash, a feature of all leadscrews other than the precision variety found on CNC machines. The acceptable amount of lost motion depends on the user, but 0.005” is generally a good compromise. Smaller numbers are possible, but overdoing it can lead to premature wear of leadscrew and nut.

Excessive backlash can be corrected by compressing the leadscrew nut. For the X-axis this is done by tightening the socket head screw in Figure 4-5. A long-handled 4 mm hex wrench is required, ideally one with an extra-thick shank to minimize flexing. The corresponding adjustment for the Y-axis, Figure 4-6, is concealed by the solid way cover. It is more difficult to get to because access to the screw is partly blocked by the leadscrew itself.

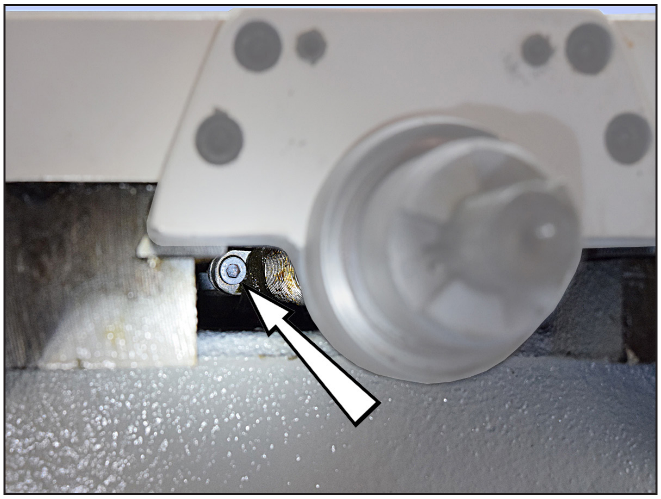


Figure 4-5 **X-axis backlash adjustment**

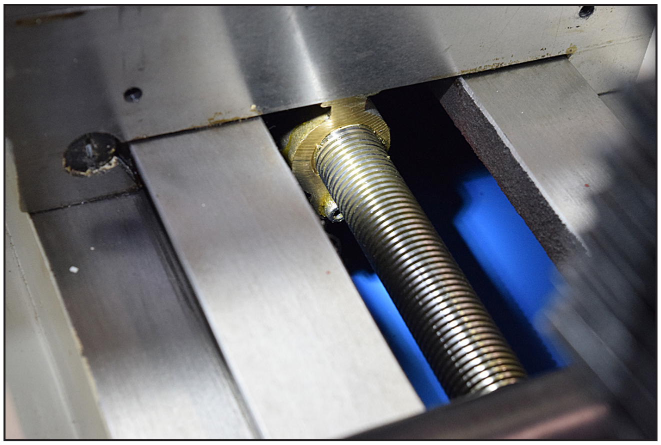


Figure 4-6 **Y-axis backlash adjustment**

DOWNFEED RETURN SPRING TENSION

The quill should automatically retract when the coarse downfeed levers are released following a drilling operation. If not, the return spring may need to be re-tensioned – but first check for other issues such as obstructions or lack of lubrication.

! ***Take extra care when working on the spring — it can unwind violently if not controlled***

A pin in the headstock casting engages in one of 6 notches on the rim of the cup-shaped spring housing. Spring tension is adjusted by disengaging the housing, see below, then rotating and re-engaging it at the desired tension – clockwise to reduce, counter-clockwise to increase.

To adjust the tension:

1. Wear heavy-duty leather gloves for hand protection
2. Loosen one half turn, but do not remove, the knob holding the spring housing in place.
3. While holding the housing firmly to stop rotation, continue to loosen the knob to the point where the housing can just be disengaged from the pin.
4. Step the housing round to the next notch, then tighten the knob to secure the housing. Test for tension.
5. Repeat as necessary, then fully tighten the knob.

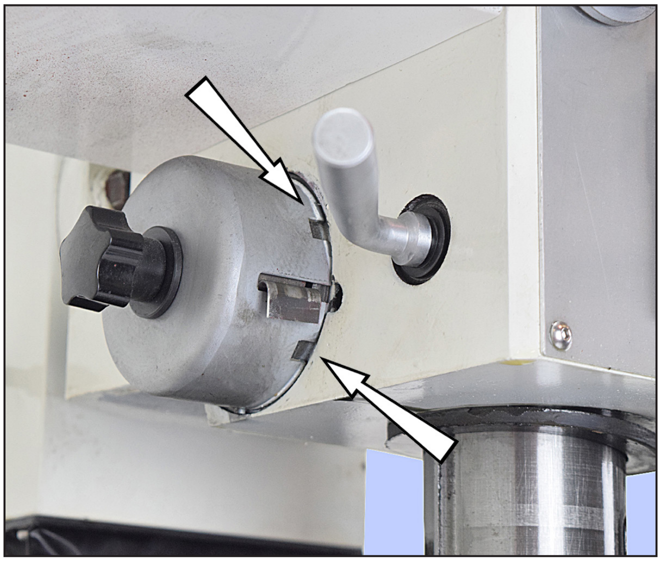
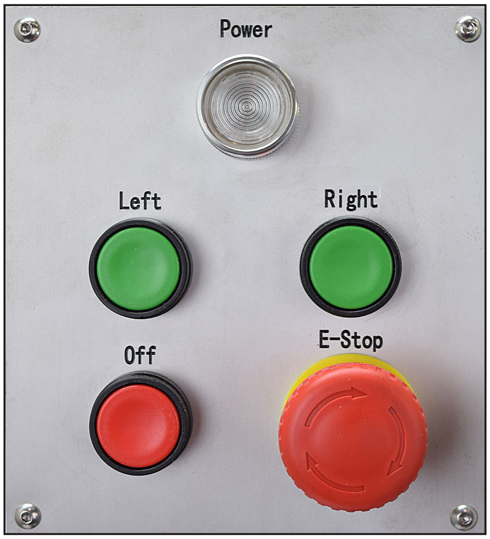
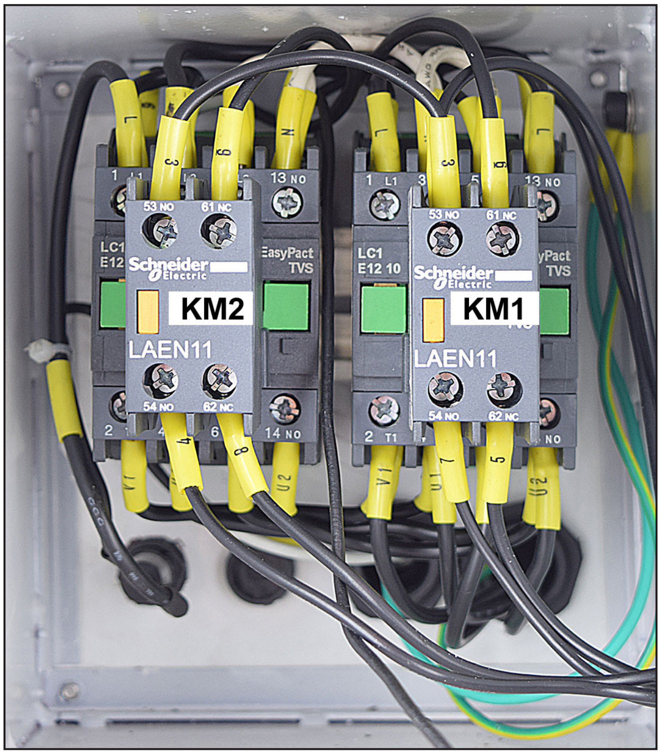


Figure 4-7 **Return spring housing**
Notches in the rim, arrowed, allow 6 radial settings

Section 5 PARTS





MOTOR CONTROLS

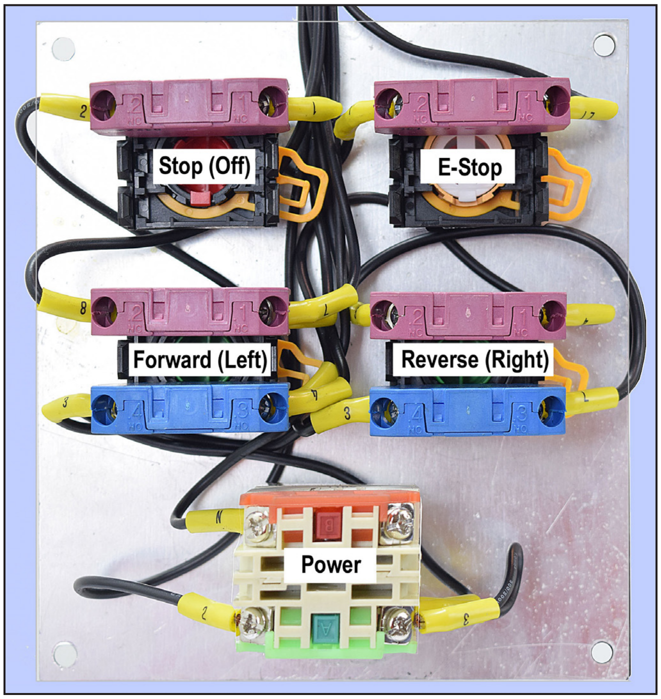
Power Press once to energize, press again to de-energize.

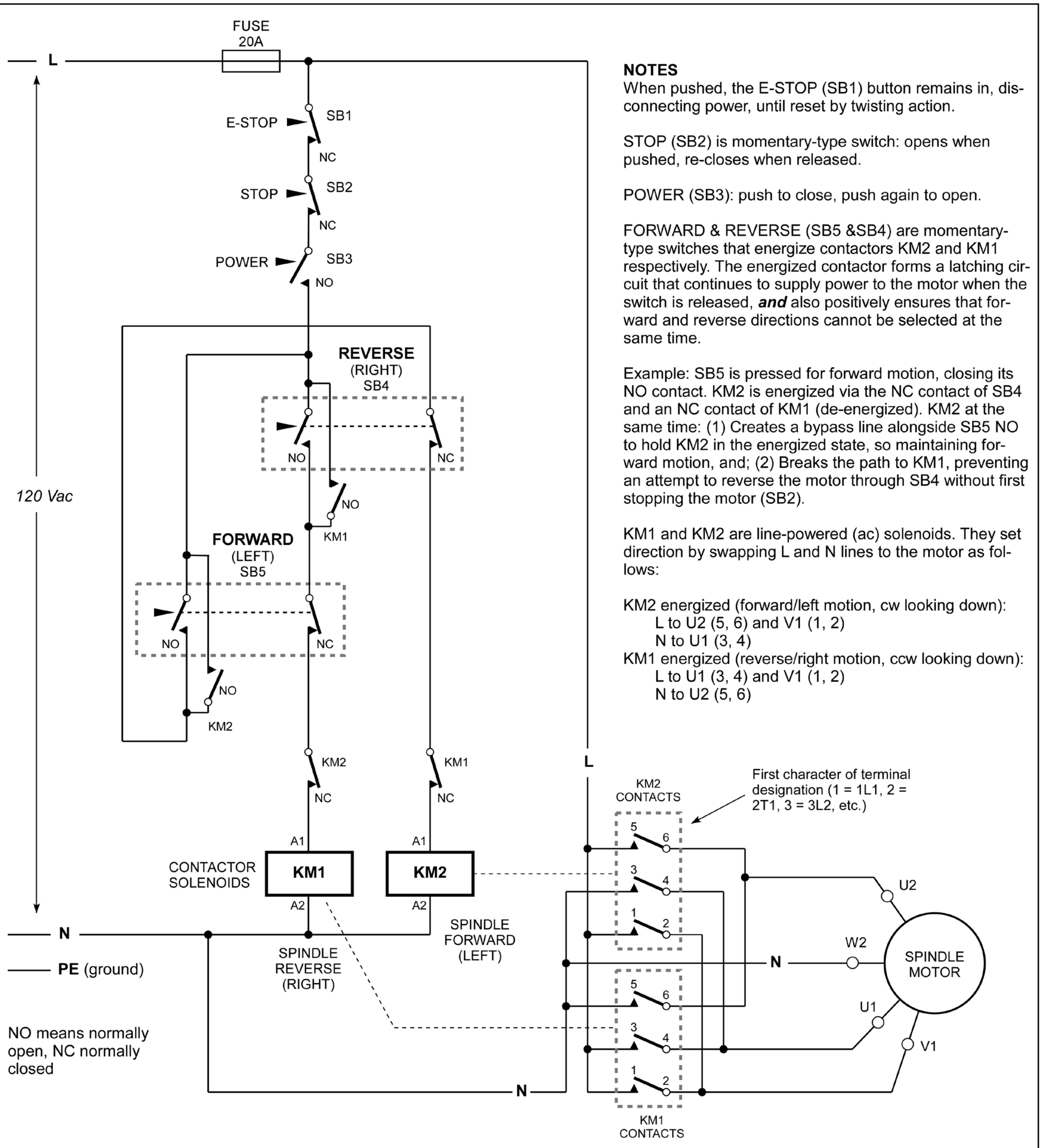
Left = Spindle Forward = clockwise looking down on mill table

Right = Spindle Reverse = counter-clockwise

Off = Stop motor

E-Stop Emergency disconnect (stays in until turned counter-clockwise to release)





NOTES

When pushed, the E-STOP (SB1) button remains in, disconnecting power, until reset by twisting action.

STOP (SB2) is momentary-type switch: opens when pushed, re-closes when released.

POWER (SB3): push to close, push again to open.

FORWARD & REVERSE (SB5 &SB4) are momentary-type switches that energize contactors KM2 and KM1 respectively. The energized contactor forms a latching circuit that continues to supply power to the motor when the switch is released, ***and*** also positively ensures that forward and reverse directions cannot be selected at the same time.

Example: SB5 is pressed for forward motion, closing its NO contact. KM2 is energized via the NC contact of SB4 and an NC contact of KM1 (de-energized). KM2 at the same time: (1) Creates a bypass line alongside SB5 NO to hold KM2 in the energized state, so maintaining forward motion, and; (2) Breaks the path to KM1, preventing an attempt to reverse the motor through SB4 without first stopping the motor (SB2).

KM1 and KM2 are line-powered (ac) solenoids. They set direction by swapping L and N lines to the motor as follows:

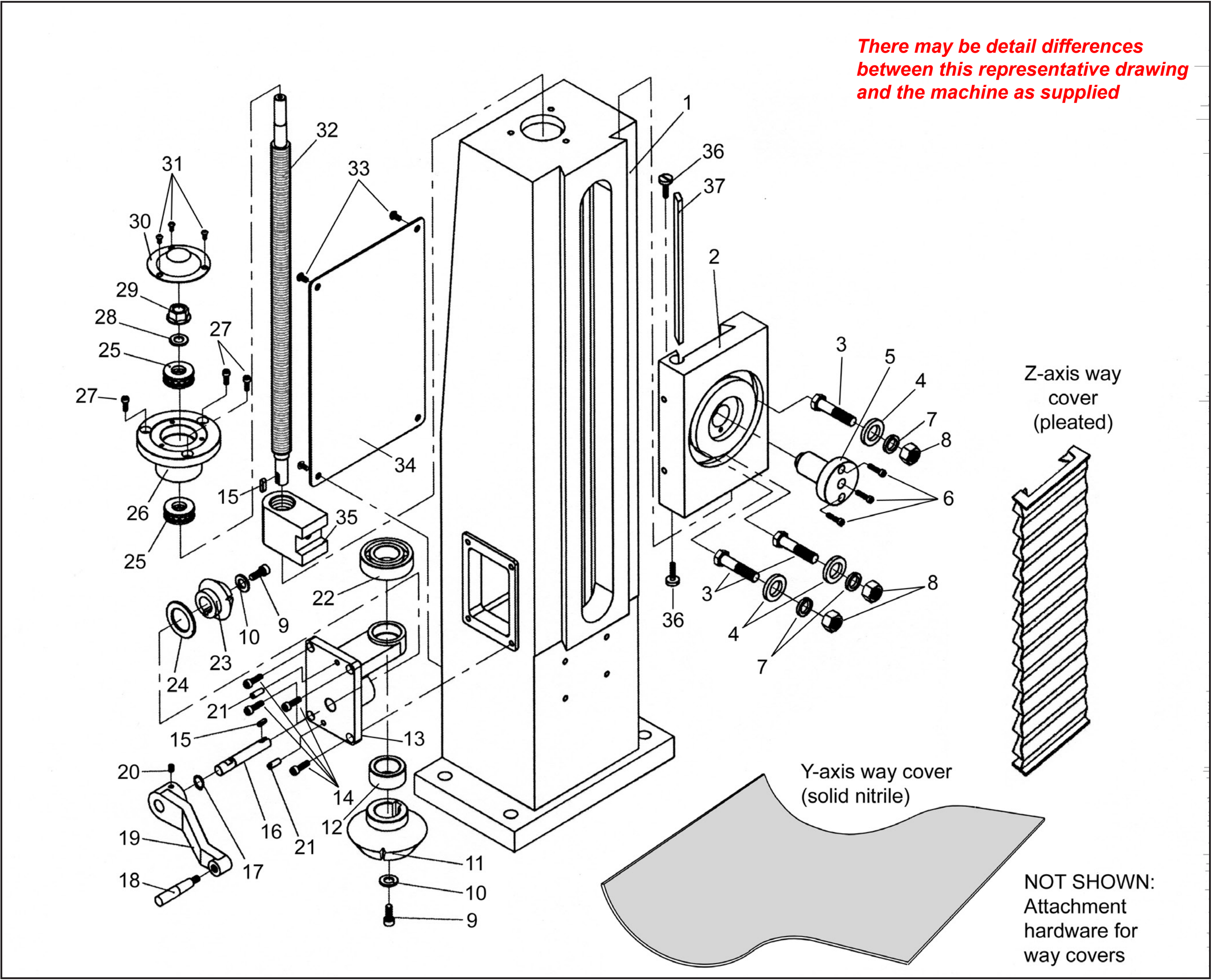
KM2 energized (forward/left motion, cw looking down):
- L to U2 (5, 6) and V1 (1, 2)
- N to U1 (3, 4)

KM1 energized (reverse/right motion, ccw looking down):
- L to U1 (3, 4) and V1 (1, 2)
- N to U2 (5, 6)

PM-727M ELECTRICAL SCHEMATIC Fig 1

This schematic is representational.
Point-to-point wiring may differ.

COLUMN COMPONENTS Fig 2



There may be detail differences between this representative drawing and the machine as supplied

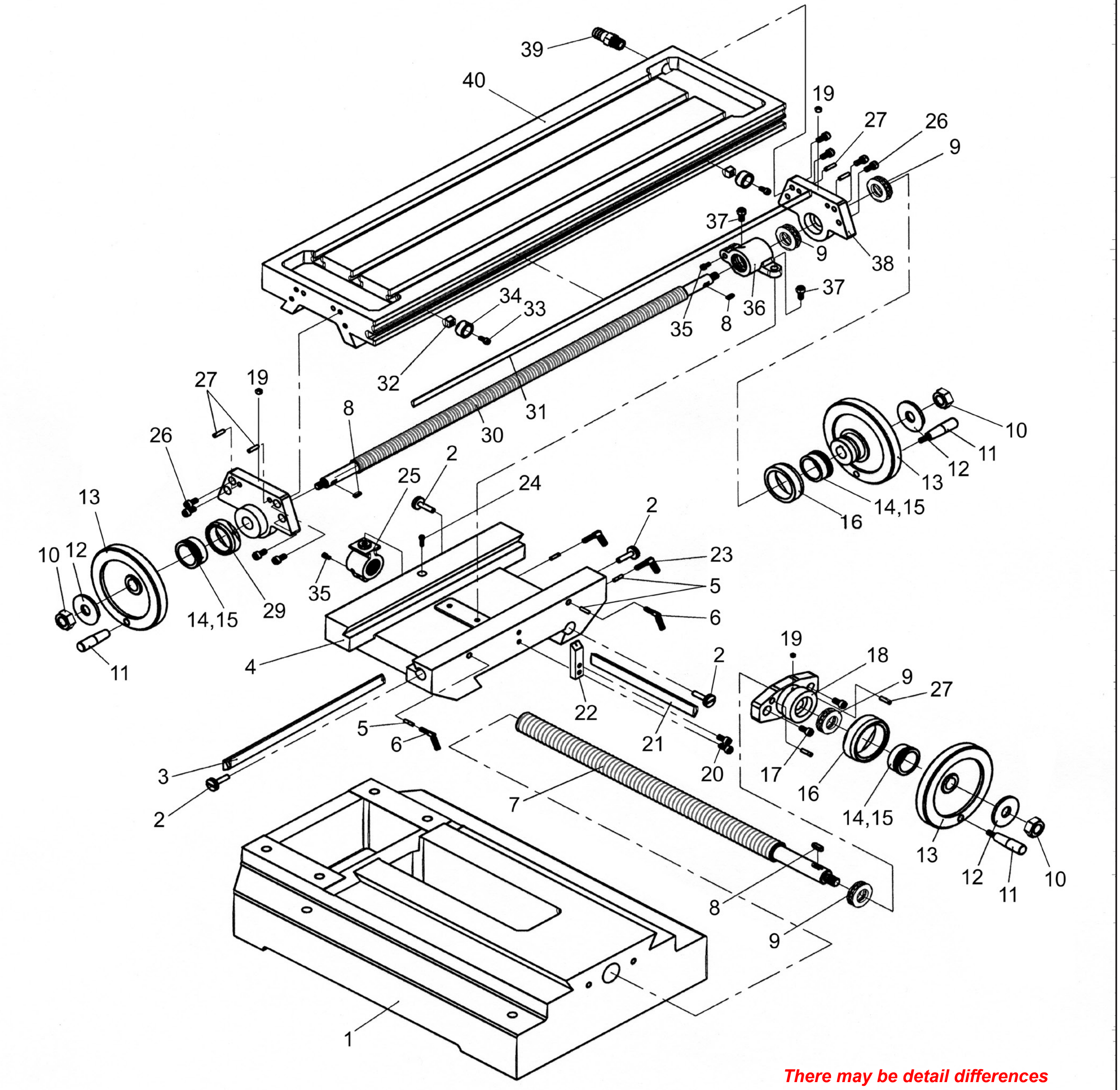
Z-axis way cover (pleated)

Y-axis way cover (solid nitrile)

NOT SHOWN: Attachment hardware for way covers

Ref	Description	Part	Ref	Description	Part	Ref	Description	Part
1	Column	Z5759	14	Screw:M6x20 skt hd (4)	Z5772	27	Screw:M6x16 skt hd (3)	Z5785
2	Headstock base	Z5760	15	Key (2)	Z5773	28	Washer: 14	Z5786
3	Screw:M12x55 hex (3)	Z5761	16	Shaft	Z5774	29	Nut, M14 flange	Z5787
4	Washer: 12 (3)	Z5762	17	Retaining ring: 15, ext	Z5775	30	Cap	Z5788
5	Connector	Z5763	18	Handle	Z5776	31	Screw:M4x8 button hd	Z5789
6	Screw:M6x25 skt hd (3)	Z5764	19	Z-axis crank	Z5777	32	Z-axis leadscrew	Z5790
7	Washer, lock: 12 (3)	Z5765	20	Screw: M8 x 12 set	Z5778	33	Screw:M5x8 button hd	Z5791
8	Nut: M12 hex (3)	Z5766	21	Taper pin 6 x 18 (2)	Z5779	34	Rear cover	Z5792
9	Screw:M6x14 skt hd (2)	Z5767	22	Ball bearing: 6002	Z5780	35	Leadscrew nut	Z5793
10	Washer: 6 (6)	Z5768	23	Bevel Gear	Z5781	36	Gib screw (2)	Z5794
11	Bevel gear	Z5769	24	Washer, special	Z5782	37	Gib	Z5795
12	Bush	Z5770	25	Ball bearing: 51202 (2)	Z5783	16	Spring washer 5/16	Z5582
13	Z-axis crank base	Z5771	26	Bearing housing	Z5784	17	Nut 5/16	Z5583

BASE & MILL TABLE COMPONENTS Fig 3



There may be detail differences between this representative drawing and the machine as supplied

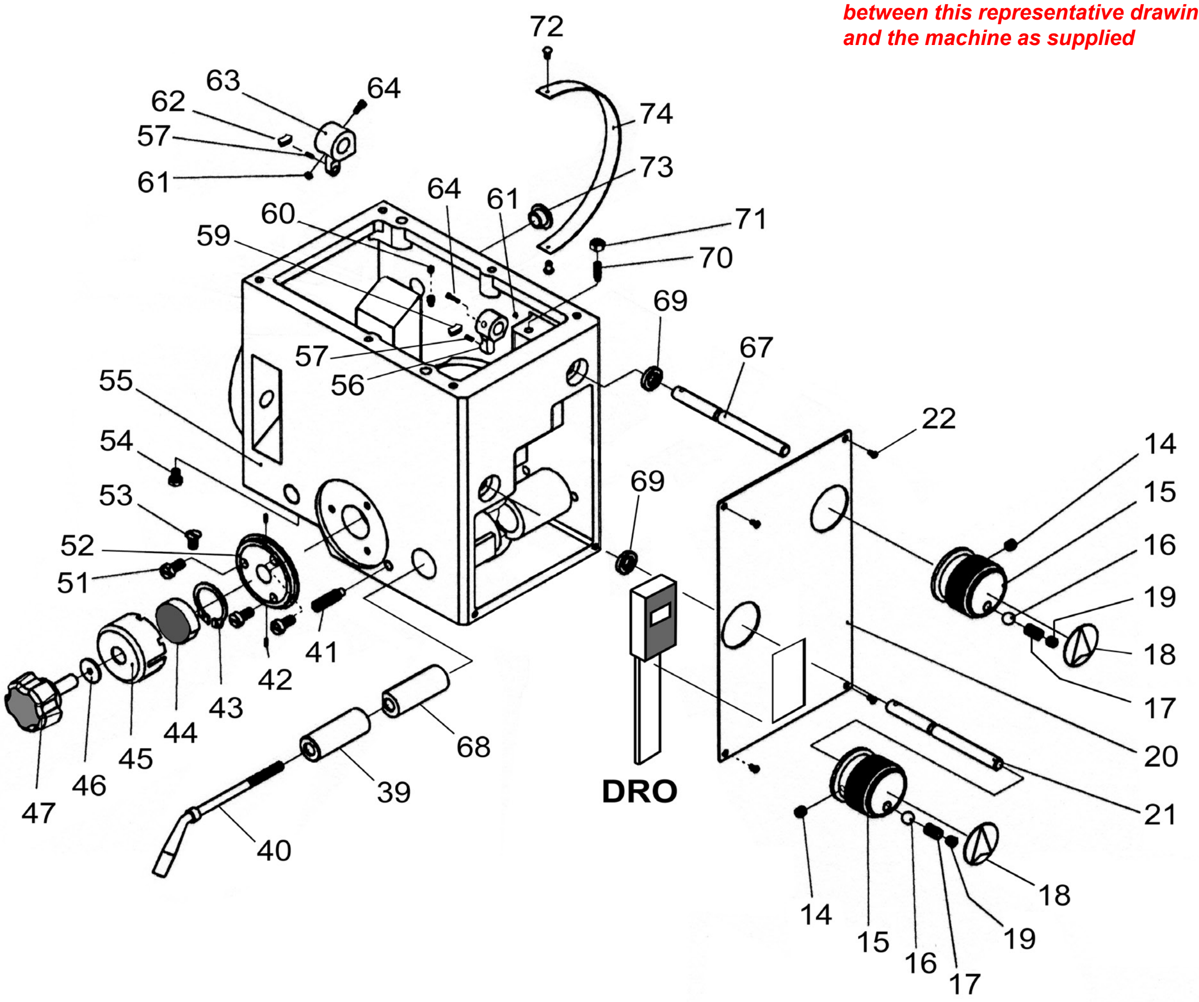
BASE & MILL TABLE COMPONENTS Fig 3

Ref	Description	Part
1	Base	Z5796
2	Gib screw (4)	Z5797
3	X-axis gib	Z5798
4	Saddle	Z5799
5	Dowel pin, 6 x 12 (4)	Z5800
6	X-axis clamp lever (2)	Z5482
7	Y-axis leadscrew	Z5802
8	Key (3)	Z5803
9	Ball bearing: 51103 (2)	Z5804
10	Lock nut, M10 (3)	Z5805
11	Handle (3)	Z5806
12	Washer (3)	Z5807
13	Handwheel (3)	Z5808
14	Friction spring (3)	Z5809
15	Graduated dial (3)	Z5810
16	Dial flange	Z5811
17	Screw: M8 x 20 skt hd (2)	Z5812
18	Y-axis leadscrew support flange	Z5813
19	Oiler (3)	Z5814
20	Screw: M6 x 12 skt hd (2)	Z5815

Ref	Description	Part
21	Y-axis gib	Z5816
22	Position indicator block	Z5817
23	Y-axisclamp lever (2)	Z5818
24	Screw: M8 x 50 skt hd	Z5819
25	Y-axis leadscrew nut	Z5820
26	Screw: M6 x 25 skt hd (8)	Z5821
27	Taper pin 6 x 20 (6)	Z5822
28	X-axis leadscrew support flange (L)	Z5823
29	X-axis dial flange (L)	Z5824
30	X-axis leadscrew	Z5825
31	Scale	Z5826
32	Nut, special (2)	Z5827
33	Screw: M6 x 10 skt hd (2)	Z5828
34	Stop block (2)	Z5829
35	Screw: M5 x 20 skt hd (2)	Z5830
36	X-axis leadscrew nut	Z5831
37	Screw: M6 x 25 skt hd (2)	Z5832
38	X-axis leadscrew support flange (R)	Z5833
39	Hose fitting (coolant drain)	Z5834
40	Table	Z5835

HEADSTOCK CASE COMPONENTS Fig 4

There may be detail differences between this representative drawing and the machine as supplied



All dimensions in mm

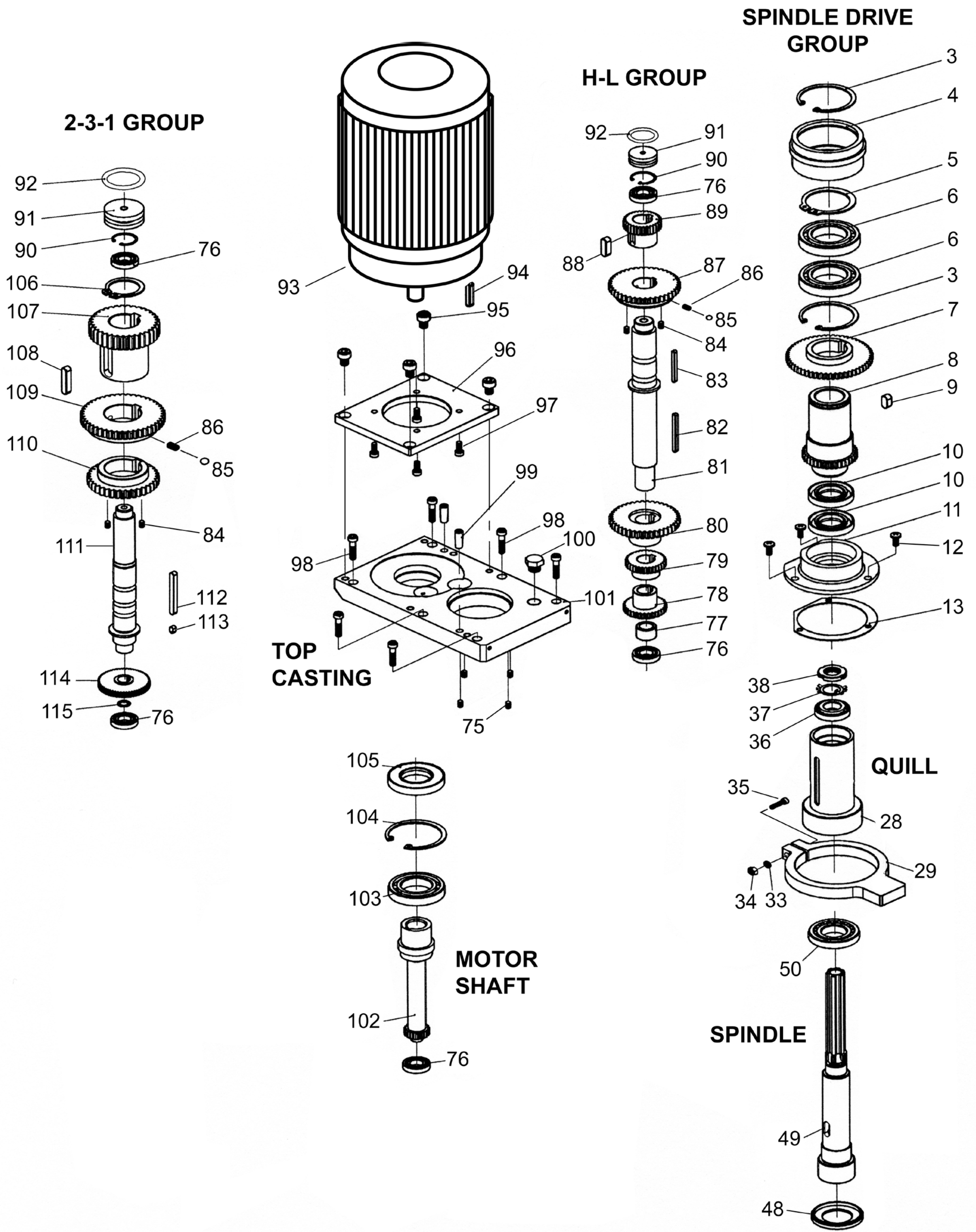
Ref	Description	Part
14	Screw: M6 x 8, set (2)	Z5836
15	Gear shift knob (2)	Z5837
16	Ball, 6.5 (2)	Z5838
17	Compression spring (2)	Z5839
18	Shift knob label (2)	Z5840
19	Screw: M8 x 8, set (2)	Z5841
20	Faceplate	Z5842
21	Gear shift shaft 2-3-1	Z5843
22	Screw:M4x6 button hd	Z5844
39	Quill lock (L)	Z5845
40	Quill lock handle	Z5846
41	Screw: M10 x 35, set	Z5847
42	Roll pin 3 x 12 (2)	Z5848
43	Retaining ring: 18, ext	Z5849

Ref	Description	Part
44	Coil spring, quill return	Z5850
45	Spring housing	Z5851
46	Washer	Z5852
47	Knob (M6)	Z5853
51	Screw:M5x10 phil hd(3)	Z5854
52	Spring flange	Z5855
53	Screw:M5x10 flat hd	Z5856
54	Oil drain plug	Z5857
55	Headstock casting	Z5858
56	Gear shift crank H-L	Z5859
57	Roll pin, 4 x 10 (2)	Z5860
58	Screw: M6 x 10, set	Z5861
59	Gear shift shoe, H-L	Z5862

Ref	Description	Part
60	Screw: M6 x 8, set (2)	Z5863
61	Nut, M6 hex (2)	Z5864
62	Gear shift shoe, 2-3-1	Z5865
63	Gear shift crank 2-3-1	Z5866
64	Screw:M4x20 skt hd (2)	Z5867
67	Gear shift shaft H-L	Z5868
68	Quill lock (R)	Z5869
69	Oil seal, 10 x 22 x 7	Z5870
70	Screw: M6 x 20, set	Z5871
71	Nut, M6 hex	Z5872
72	Rivet, 2.5 (2)	Z5873
73	Oil sight glass	Z5874
74	Angle scale	Z5875

Missing numbers are either: (1) components not fitted, or; (2) components shown in the Headstock Drive diagram

HEADSTOCK DRIVE COMPONENTS **Fig 5**



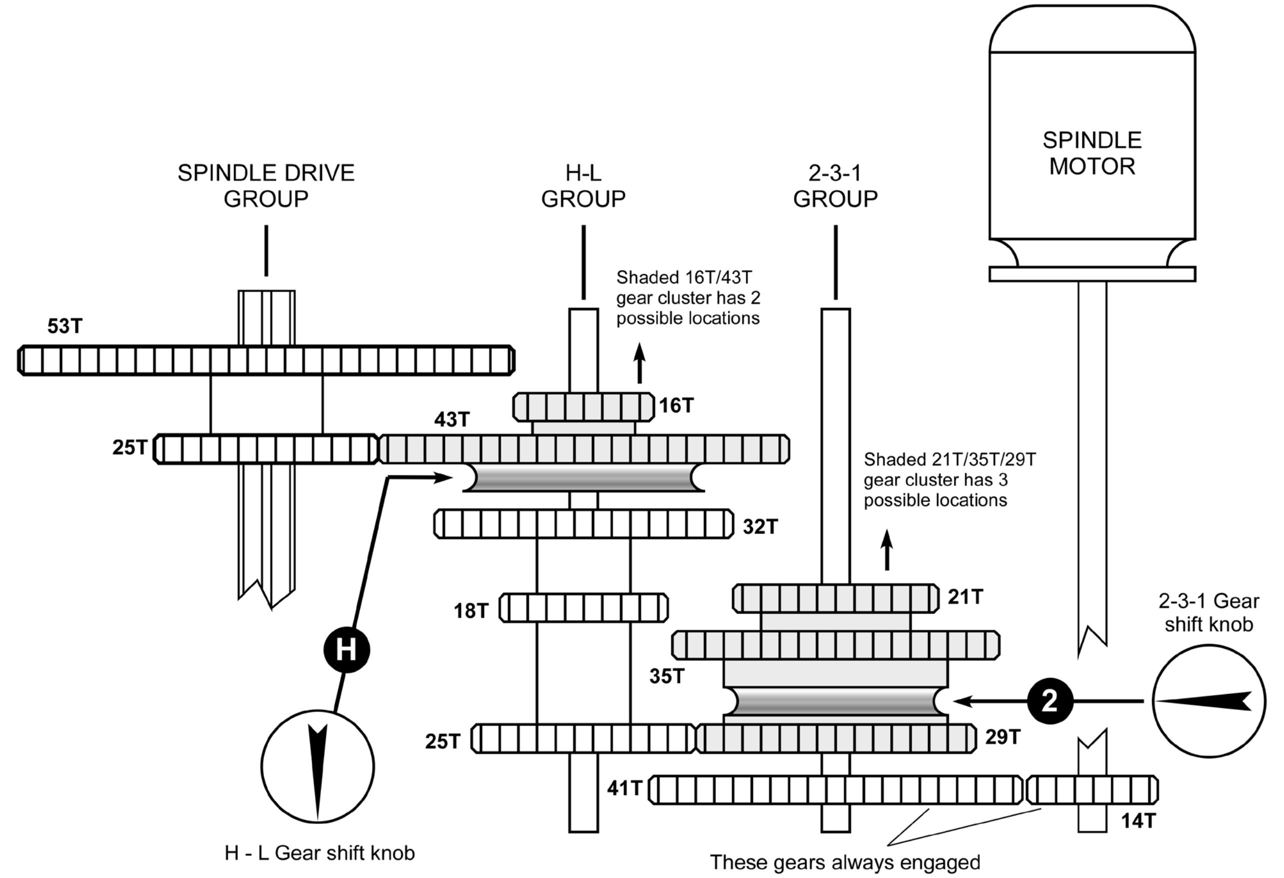
There may be detail differences between this representative drawing and the machine as supplied

HEADSTOCK DRIVE COMPONENTS Fig 5

Ref	Description	Part
3	Retaining ring: 62, int	Z5876
4	Bearing housing	Z5877
5	Retaining ring: 35, ext	Z5878
6	Ball bearing: 6007 (2)	Z5879
7	Gear: 57T	Z5880
8	Splined spindle sleeve, 29T gear	Z5881
9	Key	Z5882
10	Oil seal: 20 x 42 x 7 (2)	Z5883
11	Oil seal housing	Z5884
12	Screw: M5 x 16, ph hd (3)	Z5885
13	Gasket	Z5886
28	Quill	Z5887
29	Quill base	Z5888
33	Washer: lock 6	Z5889
34	Nut: M6 hex	Z5890
35	Screw: M6 x 35, skt hd	Z5891
36	Taper roller bearing: 30205	Z5892
37	Washer: 25, tabbed	Z5893
38	Nut: M25, spanner type	Z5894
48	End cap	Z5895
49	Spindle	Z5896
50	Taper roller bearing: 30207	Z5897
75	Screw: M5 x 10, set (4)	Z5898
76	Ball bearing: 6001 (5)	Z5899
77	Spacer bush	Z5900
78	Gear, 27T	Z5901
79	Gear, 21T	Z5902
80	Gear, 36T	Z5903
81	Shaft, H-L group	Z5904
82	Key, 5 x 70	Z5905
83	Key, 5 x 36	Z5906
84	Screw: M5 x 10, set (2)	Z5907

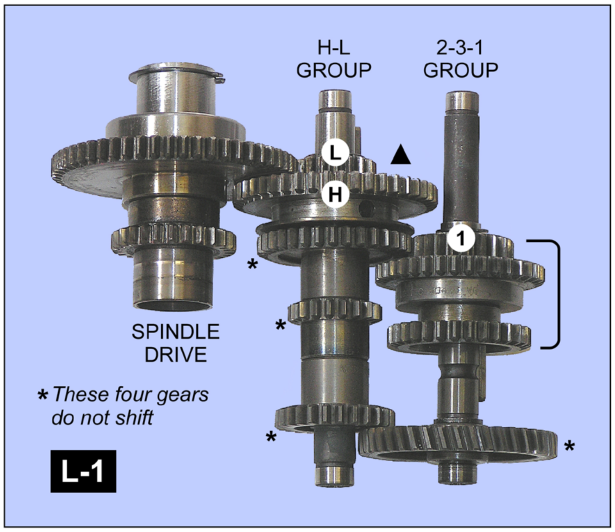
Ref	Description	Part
85	Ball, 6.5	Z5908
86	Compression spring	Z5909
87	Gear, 46T	Z5910
88	Key, 5 x 16	Z5911
89	Gear, 18T	Z5912
90	Retaining ring: 28, int	Z5913
91	Top casting plug (2)	Z5914
92	O-ring, 23.6 x 3.55	Z5915
93	Motor: 120V, single phase, 900 W	Z5916
94	Key, 6 x 36	Z5917
95	Screw: M8 x 12, skt hd (4)	Z5918
96	Motor plate	Z5919
97	Screw: M6 x 16, skt hd (4)	Z5920
98	Screw: M6 x 40, skt hd (6)	Z5921
99	Taper pin, 8 x 35 (2)	Z5922
100	Oil filler plug	Z5923
101	Headstock top casting	Z5924
102	Motor shaft	Z5925
103	Ball bearing: 6006	Z5926
104	Retaining ring: 55, int	Z5927
105	Oil seal: 30 x 55 x 10	Z5928
106	Retaining ring: 16, ext	Z5929
107	Gear, 23T	Z5930
108	Key, 6 x 25	Z5931
109	Gear, 38T	Z5932
110	Gear, 32T	Z5933
111	Shaft, 2-3-1 group	Z5934
112	Key, 5 x 60	Z5935
113	Key, 5 x 10	Z5936
114	Gear, 41T	Z5937
115	Spacer bush	Z5938

PM-727M GEAR TRAIN SCHEMATIC Fig 6

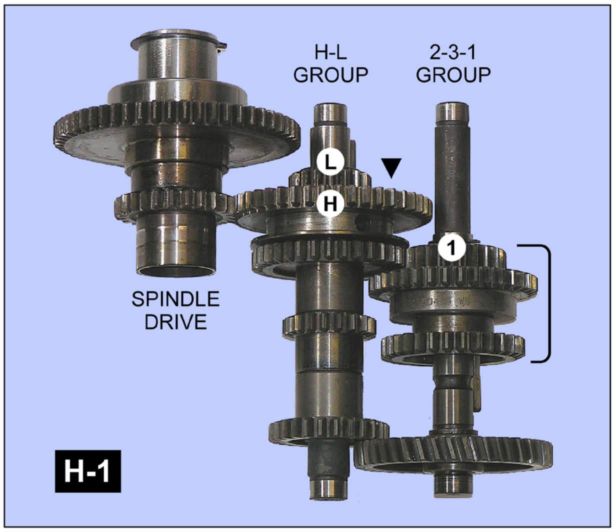

SPINDLE MOTOR
SPINDLE DRIVE GROUP
H-L GROUP
2-3-1 GROUP
53T
25T
43T
16T
Shaded 16T/43T gear cluster has 2 possible locations
32T
18T
H
25T
41T
Shaded 21T/35T/29T gear cluster has 3 possible locations
21T
35T
29T
2
14T
2-3-1 Gear shift knob
H - L Gear shift knob
These gears always engaged

This illustration is typical, not specific to the PM-727M

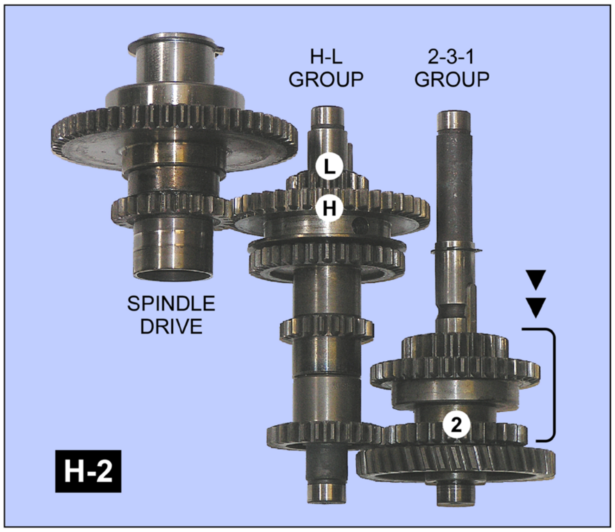
SPEED SELECTION EXAMPLES



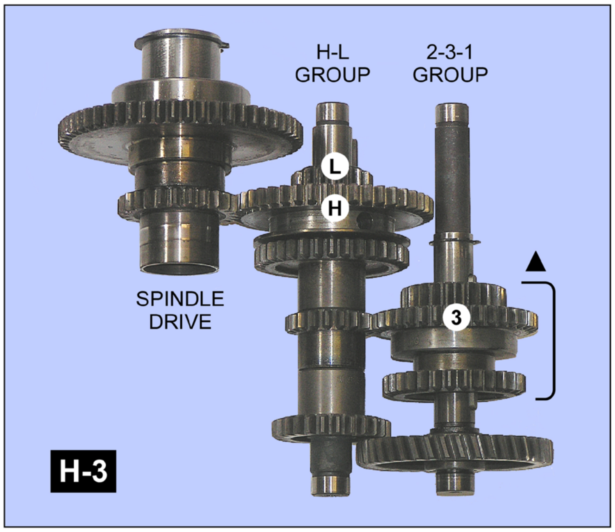
Low Range, Lowest Speed
The H-L pair is in its upper location, engaging the “L” gear with the large spindle gear. The 2-3-1 cluster is in its highest location, engaging the smallest gear (1) with the largest of the bottom three gears of the H-L group.



High Range, Lowest Speed
The H-L pair is in its lower location, engaging the “H” gear with the small spindle gear. The 2-3-1 cluster is in its highest location, same as for L-1, left.

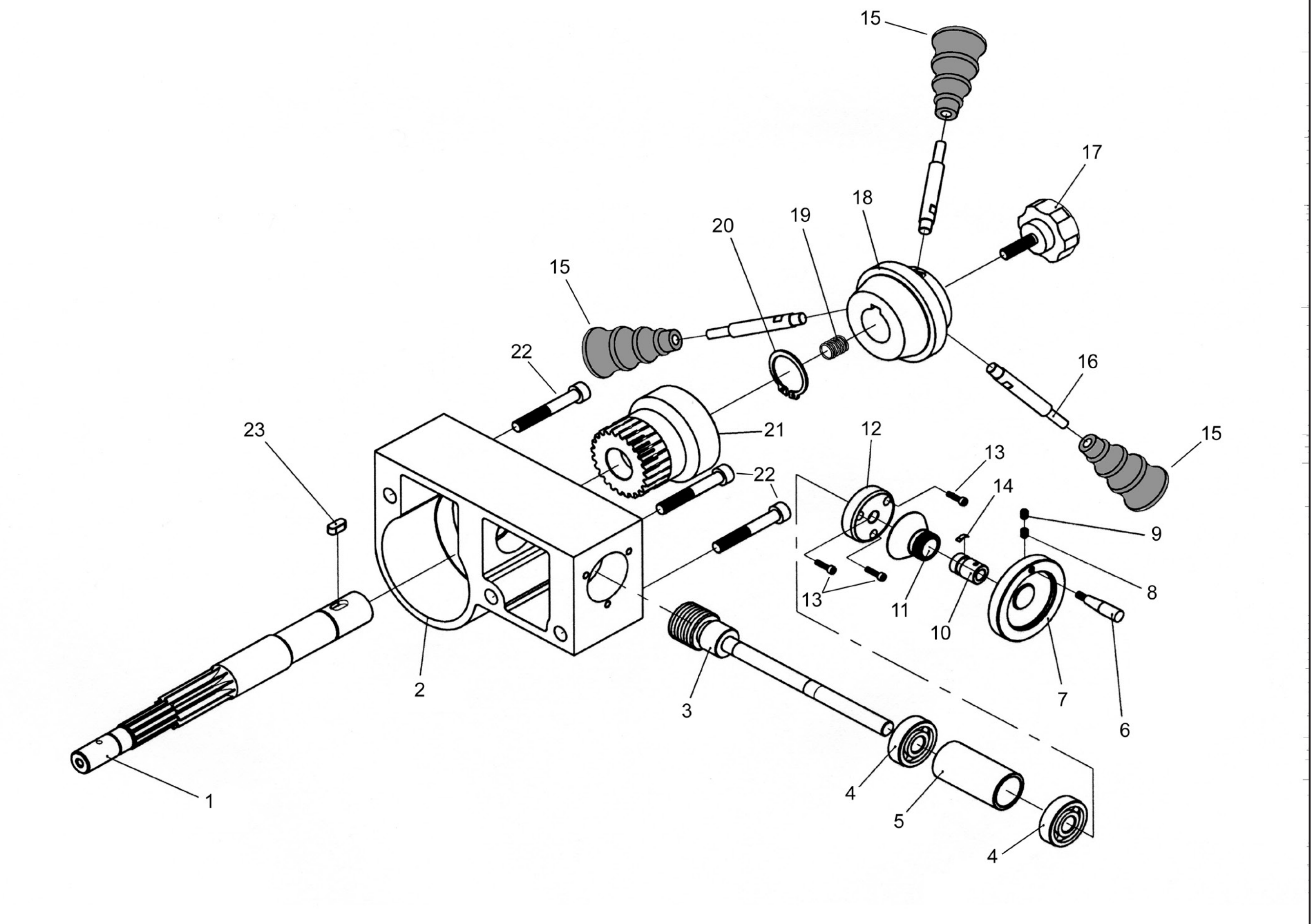


High Range, Mid Speed
The H-L pair is in its lower location, same as for H-1 above right. The 2-3-1 cluster is in its lowest location, engaging its mid-speed gear (2) with the mid-speed gear of the H-L group.



High Range, Highest Speed
The H-L pair is in its lower location, same as for H-2, left. The 2-3-1 cluster is in its center location, engaging its largest gear (3) with the smallest gear of the H-L group.

QUILL FEED COMPONENTS Fig 7



There may be detail differences between this representative drawing and the machine as supplied

All dimensions in mm

Ref	Description	Part
1	Quill pinion shaft	Z5939
2	Gear housing	Z5940
3	Worm assembly	Z5941
4	Ball bearing: 6200 (2)	Z5942
5	Sleeve	Z5943
6	Handle	Z5944
7	Handwheel	Z5945
8	Screw: M6 x 8, set	Z5946
9	screw: M6 x 5, set	Z5947
10	Dial bush	Z5948
11	Graduated dial	Z5949
12	Flange	Z5950

Ref	Description	Part
13	Screw: M4 x 7, skt hd (3)	Z5951
14	Friction spring	Z5952
15	Grip (3)	Z5953
16	Lever (3)	Z5954
17	Clamp knob	Z5955
18	Hub	Z5956
19	Spring	Z5957
20	Retaining ring: 25, Ext	Z5958
21	Worm gear	Z5959
22	Screw: M8 x 55, skt hd (3)	Z5960
23	Key	Z5961